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STAR-VUE/MARINE-VUE UPGRADES

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LANGUAGE NOTICE

Un sommaire en français de ce rapport est inclus avant la Table des matières.

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17. Abstract

This report describes the continued development of state-of-the-art display systems for ice navigation data from airborne radar and marine radar. The design for a new stand-alone marine radar display system (Marine-Vue) is presented. Software upgrades for the airborne radar display system (Star-Vue) are also described.

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17. Résumé

Ce rapport décrit l'évolution du développement d'équipement des plus au point pour la présentation d'information sur les glaces provenant de radars aérien et marin. On y présente aussi un nouveau design de présentation d'information pour un radar marin (Marine-Vue) pouvant opérer sans aide additionnelle. Vous y trouverez également une description des modifications apportées au logiciel servant à opérer le système de présentation d'information en provenance du radar aérien (Star-Vue).

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SUMMARY

This report summarizes the development of airborne and marine radar display systems, STAR-VUE and MARINE-VUE, designed to help ships navigate in ice. The participation of Canarctic Shipping Company Ltd, the Canadian Coast Guard, and of human factors experts has accelerated the development process, and enhanced the usefulness of the resulting systems.

The primary objective of the program was to implement and test defined upgrades to the display systems. The activity described here was conducted from September 1986 to March 1987.

The upgrades to STAR-VUE and MARINE-VUE included numerous software additions to ease the handling of the radar data, and to improve its effectiveness for ice navigation. These upgrades included new facilities to enter latitude and longitude information, image and colour enhancement, a system to georeference the imagery when ice conditions have changed, and a new data reception facility.

The upgraded STAR-VUE and MARINE-VUE systems were tested on the CCGS Louis St. Laurent in February 1987, and will be the subject of a separate report.

SOMMAIRE

Ce rapport présente un aperçu du développement de systèmes de présentation pour radars marin et aérien (STAR-VUE et MARINE-VUE) devant servir pour la navigation dans des eaux infestées de glaces. Au cours de la saison de navigation 1986/87, les contributions de la compagnie Canarctic Shipping Ltée, de la Garde côtière canadienne, ainsi que celle de spécialistes en facteurs humains ont contribué largement à accélérer le processus de développement, et rendre les résultats des plus utiles.

L'objet principal du programme était d'implanter et de vérifier les améliorations requises aux systèmes de présentation. Les activités décrites dans ce rapport eurent lieu entre septembre 1986 et mars 1987.

Les améliorations apportées à STAR-VUE et MARINE-VUE incluent plusieurs logiciels additionnels pour simplifier la manutention de l'information des radars, et pour faciliter la tâche de naviguer dans les glaces. Les améliorations simplifient la rentrée de données pour la latitude, la longitude, pour le choix des caractéristiques de l'image et de la couleur, pour la notation cartographique de l'image lorsque les conditions de la glace ont changées. On a également modifié la procédure de réception et son contrôle.

Les améliorations aux deux systèmes, STAR-VUE et MARINE-VUE, furent soumisent à des essais sur le navire CCGS Louis St. Laurent en février 1987, et les résultats obtenus feront l'objet d'un rapport particulier.

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STAR-VUE/MARINE-VUE UPGRADES

1. INTRODUCTION

During the 1985-1986 shipping season INTERA actively worked with Canarctic Shipping Company Ltd. and the Canadian Coast Guard under Transportation Development Centre funded programs to further develop state-of-the-art airborne and marine radar display systems for ice navigation.

To facilitate efficient and effective operations in ice, it has been demonstrated that ships require accurate and timely ice information. This is particularly true of icebreaking activities. The data required for navigation in ice can generally be divided into three categories, which depend, to some extent, on how these data are utilized. These categories are:

1. Long range planning information, which generally provides the user with the overall ice, sea and weather conditions that will be encountered within an area of operation;

2. Short range planning information, which is information on ice conditions that might impact the user within a few hours and is actually used to change the ship's course from one area to the next; and

3. Immediate operational tactical information, which describes the ice features within the immediate vicinity of the ship. This would be used to avoid hazards such as icebergs in the path of a ship.

The use of remotely-sensed data from side-looking airborne radar (SLAR) and synthetic aperture radar (SAR) has expanded rapidly in recent years so that it is now possible for marine operators to obtain reliable, all-weather information on ice conditions and hazards, even in the darkness of Arctic winter. The most advanced airborne radar systems available for commercial use are the SAR systems, STAR-1 and STAR-2, operated by INTERA. The STAR-1 system has been in operational use in the Arctic offshore for over 3 years. The STAR-2 system is a new SAR system which was put into operation in January 1987. This system is optimized for the collection of ice imagery.

While the value of this radar imagery has been obvious for some time, there was a real problem in distributing the data to users like icebreaking ships in a timely manner. Since ice information can age very quickly, delays in getting this information to these

users are clearly unsatisfactory. To improve this, INTERA developed radio transmitters and receivers to telemeter data directly from the aircraft to shipboard or land-based receivers. The most advanced version of an ice management receiver/workstation is the STAR-VUE system. STAR-VUE combines a downlink station with a video display that can be used to view the data at different resolutions while they are being collected in real time or after a flight. It includes software to plot courses and to produce hard copy or achieve data on computer compatible tape.

The real time ice information which is available from STAR-1 and STAR-2 can best be used for tactical navigation when used in conjunction with the ship's own marine radar as presented on a bright display. The system developed by INTERA is known as MARINE-VUE. MARINE-VUE uses the video outputs of a normal ship's radar and displays them in raster-scan format. With the overview of ice conditions presented by the airborne radar and the real time updating of ice location relative to the ship, provided by MARINE-VUE, it is possible to optimize a ship's route through an ice field.

Over the course of the past year the development of the STAR-VUE and MARINE-VUE systems has progressed very rapidly. The utility of these systems has benefitted from contributions made by Human Factors experts, commercial shipping operators, and by Coast Guard personnel. The successful shipboard demonstration of these systems on the M.V. Arctic has resulted in several suggestions by Canarctic, Coast Guard and TDC to expand the system functionality.

The work reported here describes several modifications that were made to STAR-VUE and MARINE-VUE systems as a result of these suggestions. The ultimate goal of these modifications is the development of a fully integrated display system called NAV-ICE for airborne radar, marine radar, and other image data. The work primarily involved changes to existing hardware and software. These changes were tested on one of the Coast Guard vessels in the Winter of 1987 under the terms of a separate contract with Transport Canada. These changes have resulted in superior products for ships engaged in Arctic transportation.

2. MARINE-VUE

A significant problem with using airborne radar imagery for tactical navigation is keeping track of the ship's progress through a moving field of ice.

For tactical navigation, it has been shown that the ship's own Marine radar provides the much needed connection between where the ice is at the time of the ship's passage and where it was when the airborne imagery was collected. By constantly tracking the ship's position in the airborne ice image with the marine radar, the airborne radar imagery can continue to be used many hours after it has been collected.

For the most part, marine radar systems have been designed to provide optimum target (i.e., other ships, navigation buoys, etc.) detection in sea clutter and poor weather. There is little or no provision in the average radar design for tracking the ship's location in a complex ice field.

The standard ship's display is the Plan Position Indicator (PPI). The video is displayed on a cathode ray tube, with a very carefully selected phosphor. The display also has several electronic signal processing options built in, which have evolved over the years to aid in ship navigation. There is a variable gain control, to reduce sea clutter (S.T.C.), a form of high pass filter (F.T.C.) to reduce rain clutter, and a form of constant false alarm rate threshold circuit. The phosphor has both a relatively bright response and a long persistence to provide for adequate target brillance between antenna sweeps.

There are two very serious drawbacks to these PPI displays. First, it is not possible to view the screen other than in nearly complete darkness, which entails looking into a hood at the screen. This makes it difficult to compare the marine radar data with other sensor data, e.g., SAR. It is also impossible to freeze the display i.e., to view an image for a long period of time.

Another major drawback of the standard PPI is the unavailability of more than one level of brightness. Basically, returns are classed as target or noise by the electronics (under operator control). In complex ice fields, all the ice is painted bright and therefore saturates the display, making adequate definition of shapes and ice types very difficult. It has been demonstrated, in research conducted by INTERA on the M.V. Arctic, using the ship's Decca radar, that a multi-grey scale display can, for the most part, overcome this problem. With an adequate STC and several levels of grey scale, quite complex ice fields can be imaged in a fashion that is quite compatible with airborne radar imagery. This multi-grey scale may also of course be colour.

For the past few years TDC-sponsored research has been able to validate the concept

of working with SAR and the marine radar in the high Arctic. A display system that INTERA developed for use on drilling ships has been used primarily for this purpose. Several other commercial, bright TV-type marine radar displays have also been evaluated. After thorough study, INTERA has recommended that scan converter manufactured by a California company called Folsom Research be used as the basis for MARINE-VUE (see TDC report TP8549E).

2.1 FOLSOM RADAR SCAN CONVERTER (MODEL 8342)

The Folsom Research Model 8342 Radar Scan Converter has been designed to digitize radar vector video and display it on a standard 525 line (RS-170) TV video output. This product is really a scan converter and not a PPI output. As such, there is not a very "user friendly" interface for this system. It really requires a computer to run it. INTERA has therefore developed a separate series of menus on the STAR-VUE system to control the Folsom unit. Some of the features of the scan converter include a 6-bit radar image plane with three separate overlay planes, variable fade time constants, a NON-VOLATIVE RAM to retain the current commands and settings during power down, 3, 6, 12 and 24 n mile scales, annotation overlays with range information, image rotation fuctions, and an interface to log data onto a video recorder.

The 8342 has four functional common modules which are shown in the block diagram of Figure 2.1.

INTERA recommended that TDC purchase a Folsom unit in the spring of 1986 along with a personal computer and tape drive to be used for logging data. Software was developed for this data logging function and a plan was developed for the testing of the marine radar display systems. Because the Folsom Box was untested for imaging ice, it was decided that it should be compared to INTERA's RIDS for quality of display on the spring voyage of the M.V. Arctic.

The testing on the M.V. Arctic involved a detailed comparison of the RIDS and the Folsom units. Both systems were equipped to log data for later analysis in the lab.

2.2 SHIPBOARD TRIALS

Both the RIDS and the Folsom systems were installed on the M.V. Arctic in Montreal in May 1986 for shipboad trial on the vessel's voyages to the Arctic. Both systems were equipped to log data for later analysis in the lab. The RIDS system was equipped with a Kennedy tape drive for this purpose. An IBM-AT with a IEEE-488 bus interface was used to record data from the Folsom system. Radar scanns from the Folsom system were subsequently logged to cassette tape using a Tallgrass 60 Mbyte tape recorder.

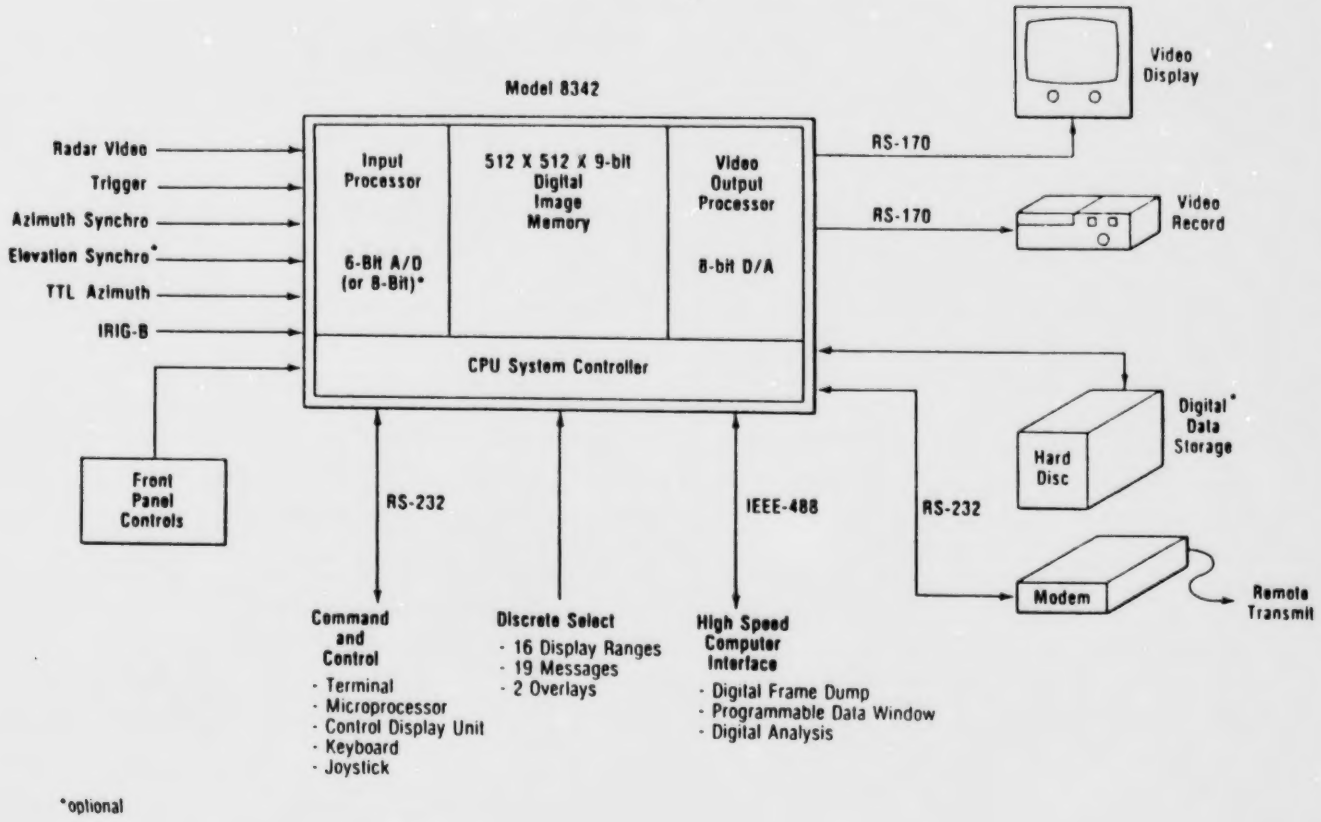


Figure 2.1 Block Diagram of the Folsom Scan Converter.

Two modifications had been added to the RIDS, one for STC and a second for scan-to-scan averaging. Unfortunately, the scan-to-scan averager failed to function as planned due to a defect in either design or implementation. The radar images therefore failed to register properly.

The new STC curve generator, however, performed very well. A qualitative evaluation of the STC curve generator resulted in several features near the ship being visible, features that would normally have been saturated. The fact that the STC curves could be modified in several ways provided a very flexible tool for enhancing near range features.

Data were collected using the Folsom system for a variety of ice conditions under relatively calm sea states. These data were accompanied by full ship atmospheric and oceanic conditions and, when possible, photographs of pertinent ice features. Unfortunately, no RIDS data were collected due to a tape drive failure.

Further comparison between the RIDS and Folsom system were made during the next voyage of the M.V. Arctic from Antwerp to the Arctic. The image quality of the Folsom system compared reasonably with the PPI in the calm conditions encountered. Sea clutter suppression was not available on the Folsom unit so near range clutter was flagged as a potential problem in rough seas and in heavy ice.

The displayed resolution of the Folsom system was much better than the RIDS due to the scan conversion method used in the Folsom system. By sampling every pulse, noise patterns did not show up on the display. This was a problem with RIDS. More data were collected during the voyage for lab analysis.

The Folsom system was again used onboard the M.V. Arctic for the 1986 Bent Horn voyage. No specific program was conducted by INTERA personnel so Canarctic personnel were encouraged to provide feedback. They were critical of the lack of nautical functions available on the system since they were used to a PPI display.

In October of 1986 new software and hardware were brought to LCI to try the first integration of the Folsom system with the STAR-VUE system. The Folsom addition to the STAR-VUE was called MARINE-VUE. This allowed the radar display to be controlled from a single console.

A single asynchronous interface (DLVEI-M) was introduced into the STAR-VUE backplane in order for STAR-VUE to communicate with the Folsom system. A new set of menus was also added to the STAR-VUE system to control the Folsom box via an RS-232 interface.

The menu system worked well; however, the main drawback with the implementation of MARINE-VUE was the inability of the system to rotate the image to the same orientation as the SAR image on STAR-VUE. This made it difficult to match the SAR and marine radar.

2.3 MARINE-VUE REQUIREMENTS

From all the above mentioned TDC-sponsored research and development, it is clear that the requirements for the MARINE-VUE marine radar display system were firmly established. They can be summarized as follows:

1. The system must present marine radar data on a bright TV-type display. This display should refresh in real time and allow an individual image to be frozen on the display for any length of time.

2. The system should be able to interface to any radar without overriding the normal radar controls.

3. The system should display both north up and ship's head up radar data.

4. The image should be displayed with the normal radar ranges of 0.75, 1.5, 3, 6, 12, 24 and 48 nm.

5. The display must have at least 2 bit of video display and should have a choice of colour or black and white presentation.

6. It should have the normal radar signal processing such as STC and FTC available.

7. The user interface should have controls that are similar to or emulate those of a standard radar. It must be easy to use by ship's crew, ice observers and those familiar with radar systems.

8. The system must have a standard computer interface so that data can be shared with other computer systems.

9. The equipment must be reliable and robust and suitable for mounting on the bridge of a ship.

2.4 MARINE-VUE DEVELOPMENT

During the time frame of this project, several key decisions were made regarding the MARINE-VUE system. It was determined that the RIDS system would have to be redesigned to perform the majority of its functions in hardware. This, however, would require a major redesign and equipment build. The Folsom unit was found to be a much higher quality display unit than the RIDS or the JRC units, which were used for comparison. This is because the Folsom unit displays every radial pulse and writes an extremely high quality display result into memory. The scan average that was implemented on the RIDS failed to perform as expected due to hardware problems. Because of the success of the Folsom unit, further work on the RIDS and RIDS scan average was therefore abandoned.

Although the Folsom unit proved to be the best available display system for MARINE-VUE, several other features were found to be lacking. These include:

1. A "stand-alone" interface that is easy to use for controlling all radar functions;

2. An interface to the ship's gyro for ship's heading mark;

3. An adjustable range and bearing cursor;

4. A front panel and computer control for intensity, gain and threshold;

5. Clutter removal circuits (STC, FTC); and

6. Range rings.

In addition, shipboard research has shown that several desirable features could be added to improve the utility of the system. These include user selectable scale settings beyond the ranges of 3, 6, 12 and 24 n.mi. , and some form of scan averaging.

It was clear to INTERA that, to address all of the above concerns, was clearly beyond the scope of this project. INTERA also felt that most of the required functionality should be incorporated into the Folsom hardware by the manufacturer. As a result INTERA undertook a detailed design study with Folsom. Another TDC client was also seeking a radar scan-converter for a more conventional application (i.e., ship in open water).

INTERA and Folsom worked together to provide a detailed design for a stand alone MARINE-VUE system to meet the needs of ships in ice as well as ships requiring a

more conventional radar display. TDC is currently funding the development of this equipment under a follow-on contract with INTERA.

Two additional changes were made to the Folsom unit under this contract:

1. A hardware change was made to the Folsom unit to allow radar images to be rotated by any arbitrary amount. Software was written for the MARINE-VUE interface to STAR-VUE to allow the radar operator to accomplish this task (Figure 2.2).

2. An IEEE-488 interface was purchased for STAR-VUE to allow for both the transfer of control and image data from the Fc som Unit. For future research programs this will eliminate the need for both an external computer and tape drive since data can be transferred directly to STAR-VUE for storage, display or hardcopy printing. This would allow for example, both SAR and Marine Radar data to be viewed on the same display if required.

One of the more interesting developments in the area of marine radar technology from the ice perspective, is the use of cross polarized returns to discriminate icebergs/old ice in new ice "clutter" (Ed Lewis personal communication). By use of a standard marine radar transmitter, dual standard receivers, and a V polarized, receive only antenna. CCIW has succeeded in building a dual polarized (HH and HV) radar.

The dual-polarized data collected on the M.V. Arctic to date show tremendous potential for such a radar in distinguishing hazardous iceberg/old ice conditions. The display requirements for such a radar system to be incorporated into NAV-ICE however, are much more complex than for a single like polarized channel. During this project INTERA has indicated how a dual polarized radar could be integrated into NAV-ICE.

2.5 MARINE-VUE DESIGN

The system design is intended to eliminate certain shortcomings of the existing hardware and software, and to integrate the dual polarization radar data into the ship's operation. Figure 2.3 is a conceptual block diagram of the final system showing the proposed upgrades which could be tested on the M.V. Arctic.

The TDC Folsom unit must be upgraded with both new hardware and software, to be supplied by the manufacturer. In addition, a new front end video processor should be fabricated (by INTERA) to complete the marine specific video processing tasks. Since the scan converter is physically isolated from the video display (where the operator normally sits), to ensure ease of use, a new operator's control panel should also be

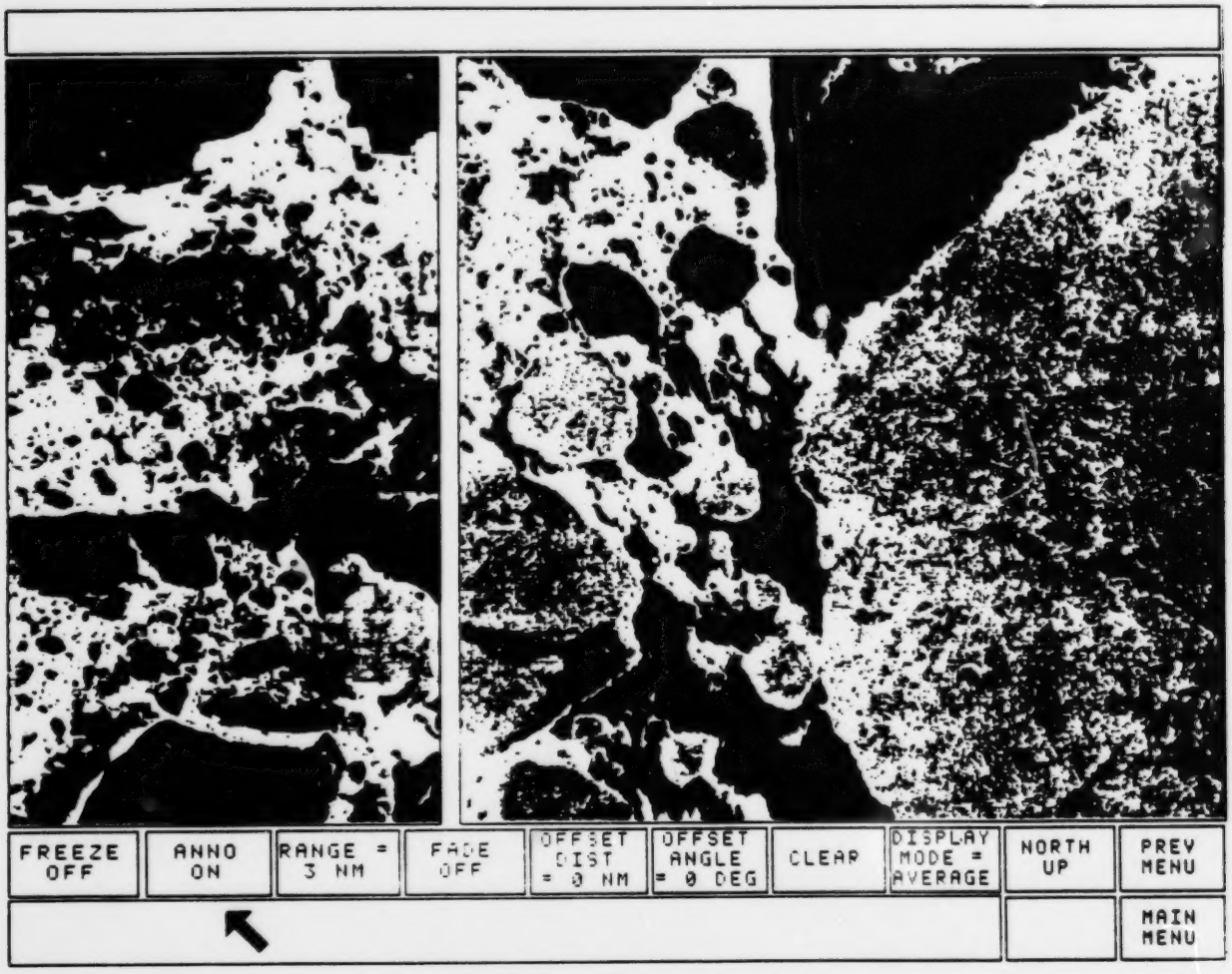


Figure 2.2. Marine-Vue Menu on STAR-VUE (note functions for offset distance and offset angle.

designed to go with the display. This would communicate directly with the scan converter over an RS-232 line, using a small micro-processor. A limited number of functions should also be controllable from the MARINE-VUE menu on STAR-VUE, to facilitate tactical navigation. Lastly, a new colour video board should be installed in the TDC MARINE-VUE, to allow color or black and white imagery to be displayed.

To facilitate the integration of the dual-polarized radar a new radar video mixer must be developed to combine the HH and HV radar data. Since both data streams result from a single radar transmission, they can be easily combined. It is proposed to make the output from this combine variables between either the HH or HV, or some combination (i.e., add, subtract ratio, etc).

An RGB Combiner needs to be developed to allow the output of the two scan converters to be mixed. As the antennae from the two units are not synchronized, this could present interpretation problems. Technically, synchronizing the two scans (of the video signals) is straightforward. This will allow, for example, the ship's HH radar returns to be painted as shades of black and white, with the HV/HH return as a coloured image, on the same screen.

It is also suggested that the MARINE-VUE and STAR-VUE displays be further upgraded. Specifically, those controls needed to adjust the scale and aspect of the MARINE-VUE image must be controlled directly from the STAR-VUE menu. This will allow for the best possible image-to-image correlation. Data storage, for post-voyage analysis, could also be done via STAR-VUE.

2.5.1 TDC MARINE-VUE UPGRADES

Specifically, the following desired additions are required of the Folsom unit:

1. Differential Synchro

   The unit must be made to accept ship's gyro compass input to allow a continuous "north-up" display as an option to the currently available "heads-up". An operator-actuated heading marker could also be added.

2. Marine Type Cursor

   A live cursor with continuous readout of range and bearing needs to be added, along with range rings, in nautical units and an azimuth bearing ring.

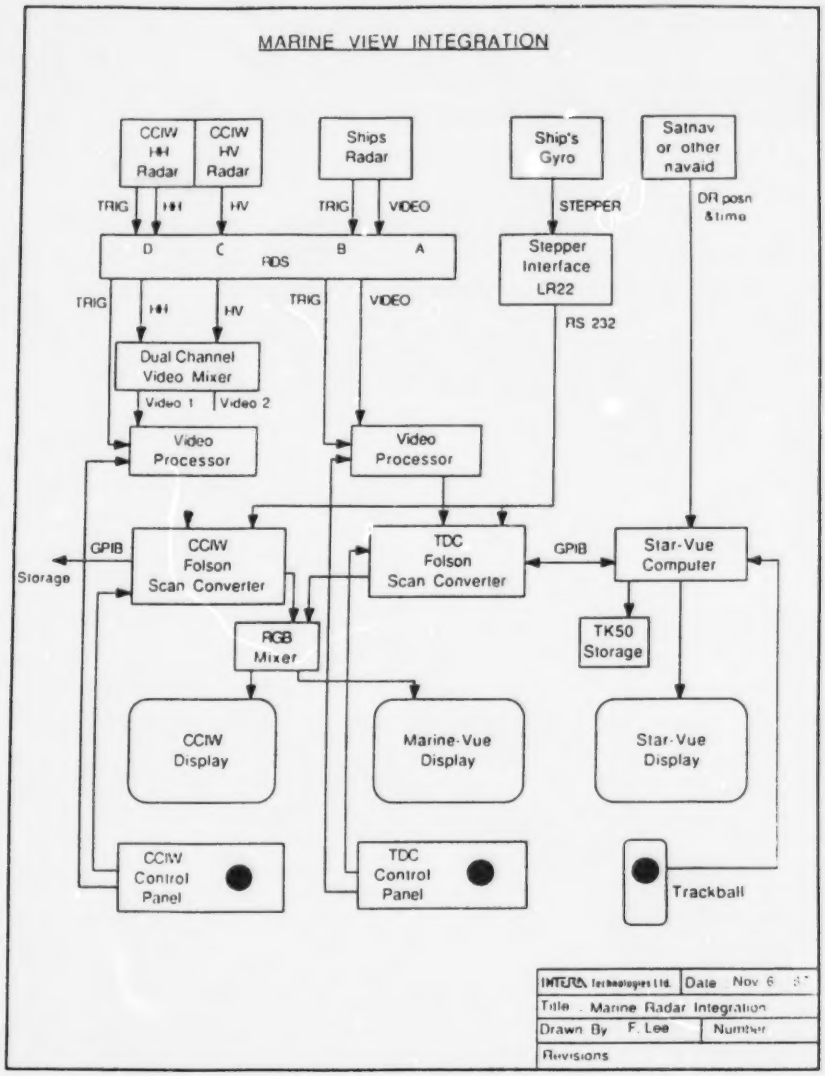


Figure 2.3 Conceptual block diagram of new MARINE-VUE system installed on M.V.Arctic.

3. Noise Suppression

Returns that are both very strong, and exist for only one radial are, for the most part, interference from other radars. These should be "black holed" according to the standard marine practice.

4. Colour Board

The output of the system should be modified with a colour look-up table on the video output. This will provide an RS-170 RGB signal.

5. Radar Video Processor

A new video processor (card) needs to be installed in the Folsom unit to process the radar video. Figure 2.4 shows a functional block diagram of this unit. It has all functionality controlled by the main Folsom processor. Local circuitry is controlled by a microprocessor. The functions that need to be implemented are:

a. STC (Sensitivity Time Control)

Range dependent gain, using a law handed down from the main CPU.

b. FTC (Fast Time Constant)

A fast time constant circuit, controlled by the CPU, to allow rain returns, etc., to be largely eliminated.

c. Gain and Offset

A digitally controlled gain (0 to +20db) and a digitally controlled DC offset (+/- 20% of scale) to maintain standard scale.

6. MARINE-VUE Control Panel

The current Folsom scan converter is controlled via a control panel on the front of the unit, or via an RS-232 port. Both communicate with the CPU, which then implements the desired changes to system operation. For operator convenience, a "marine" type control of the entire MARINE-VUE

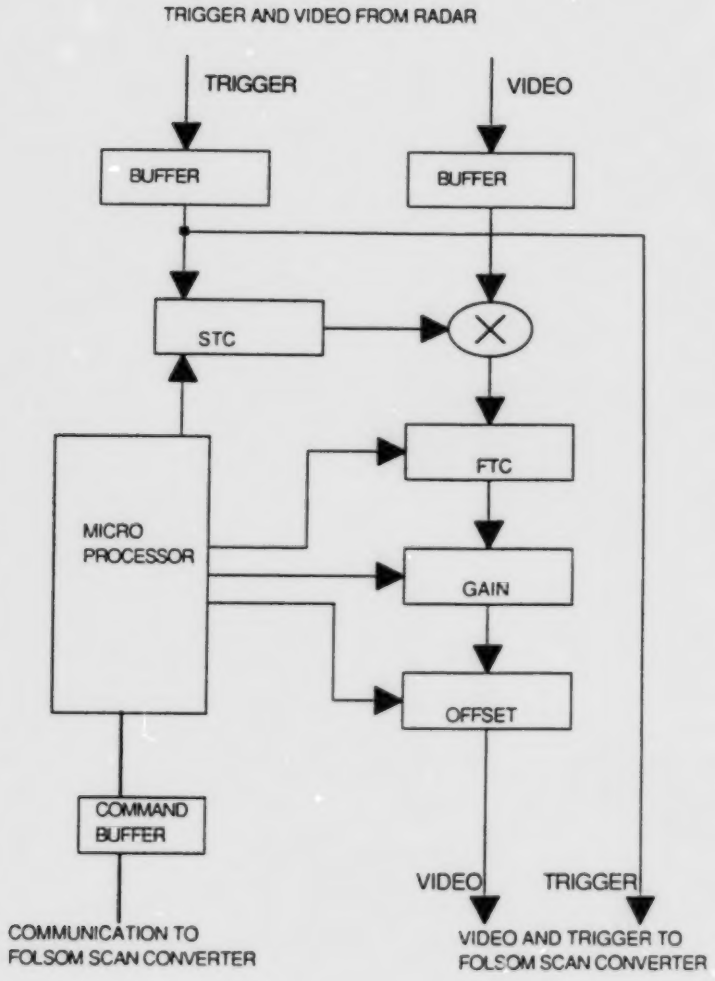


Figure 2.4. Proposed radar video processor card.

system should be located at the NAV-ICE console. This will communicate with the scan converter CPU via an RS-232 line. A small microprocessor will be used in the control panel to convert the control signals to RS-232 signals. A layout of the control panel is shown in Figure 2.5. Functions which are controllable area:

i) Range - 3, 6, 12, 24 nm miles;
ii) Video Gain - 0 to 20 db (2db steps);
iii) Video Offset - 0 to + 20%;
iv) Orientation - 0 to 360o offset from head/north-up;
v) STC - Threshold;
vi) STC - Time constant;
vii) FTC - On/off;
viii) Trackball, range and bearing cursor (over entire screen);
ix) Trackball, PPI origin (over entire screen); and
x) STAR-VUE control indicator (on/off).

Control of the scale, orientation, and x, y origin can be given over to STAR-VUE.

2.5.2 ADDITIONAL FEATURES

1. MARINE-VUE scale and orientation

During tactical navigation, it is necessary to locate the position of the ship on the SAR to match the MARINE-VUE image to the STAR-VUE image. This is greatly facilitated if the images are both of the same scale and orientation. This function should be implemented as part of the MARINE-VUE upgrade.

The SAR flight lines are typically not flown to optimize a "north-up" display. Therefore, it is necessary to rotate the MARINE-VUE image to match the SAR. If a north-up display is on the MARINE-VUE, and STAR-VUE knows the SAR orientation, STAR-VUE can command the marine image to be rotated to match. Similarly, the marine image scale can be modified to match the STAR-VUE scale. In this way, the operator can command STAR-VUE to produce a customized marine display that will match the SAR image. Some fine tuning of the orientation will be allowed, to account for ice drift since the SAR data were collected.

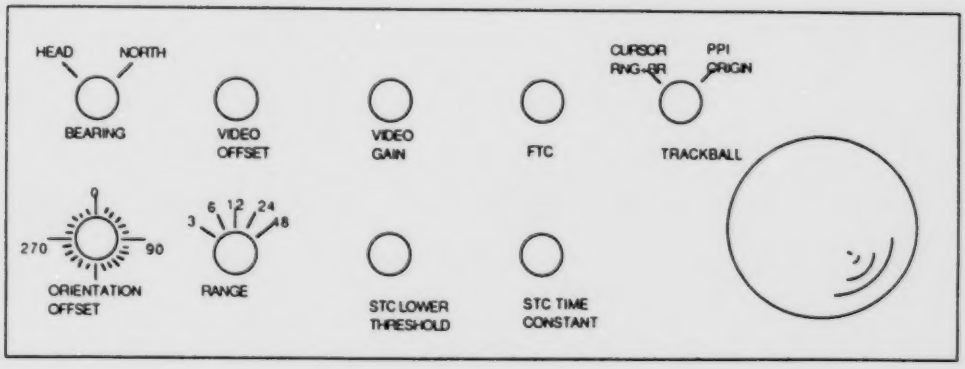


Figure 2.5. Proposed MARINE-VUE control panel.

2. STAR-VUE Satnav Position Upgrade

The ship's navigation system, based on a Satnav or GPS receiver, could also be fed into STAR-VUE. An annotation feature for data collection could also be added.

With the ship's position known to STAR-VUE, an accurate record of ship's location and time could then recorded and displayed on the STAR-VUE while in navigation mode. This would also allow predictions of actual locations for hazards and features relative to the satellite locations of the ship. It would also allow direct observation of ice drift velocities to be made on STAR-VUE.

3. Logging of SAR/Marine Data

The STAR-VUE and MARINE-VUE images are correlated by the ship's operator, as part of the tactical navigation task. It is proposed to take advantage of this record by logging appropriate SAR/marine radar pairs for later anlaysis and training. The operator, once on image has been correlated, will, with a single command, store both a SAR frame and the appropriate marine image, at the same scale and orientation. This will be accompanied by appropriate header information needed to interpret the imagery.

3. STAR-VUE UPGRADES

A primary objective of this TDC funded program was to implement and test upgrades to STAR-VUE. However, at the time that the proposal to do this work was written, STAR-VUE was still in the developmental stages. The work statement that resulted was not very accurate. During October and December 1986, the STAR-VUE system was tested in actual operations on the M.V. Arctic. As a result of this testing it became obvious that many software changes were required to make STAR-VUE a better ice navigation tool. Many of these required software changes have therefore been implemented under this TDC contract. The final system resulting from all these changes was demonstrated during a field program for the Canadian Coast Guard in February 1987.

3.1 NEW STAR-VUE FUNCTIONALITY

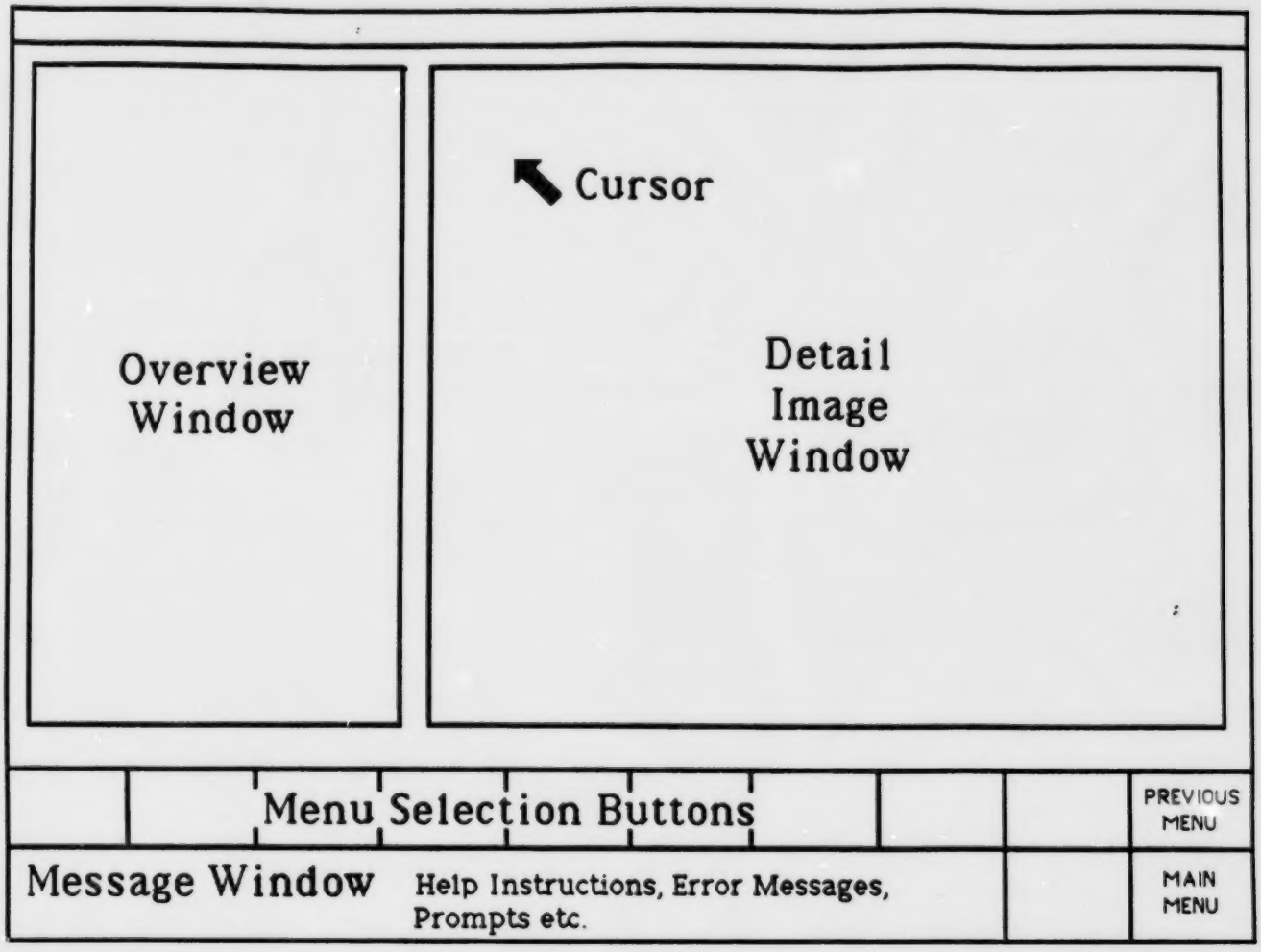
A number of new functions have been added to the baseline STAR-VUE system as a result of this contract. These functions were incorporated into the standard STAR-VUE graphics interface described briefly below.

3.1.1 GRAPHICS DISPLAY MENUS

Figure 3.1 illustrates the format of the STAR-VUE Graphics MAIN MENU screen with each of the key features labeled. Towards the bottom of the screen there is a row of Menu Selection Buttons, which allow the operator to command STAR-VUE. The cursor, shown as an arrow, is linked to a trackball device, so that the arrow is moved in the direction the trackball is rolled. To select from the menu of buttons, the cursor is rolled down until its tip rests within the bounds of a particular button. To select this choice, the operator clicks on the trackball's leftmost three buttons, and a command is executed.

Beneath the Menu Selection Buttons is a Message Window. The term "window" is used to describe a bounded region of the screen intended to display a specific set of information, either with text or graphics. The Message Window displays text information, the nature of which depends on the current command being performed. The text may provide help, error messages, instructions, or information to the user. To the right of the Menu Selection Buttons and Message Window are a set of Standard Buttons, which appear on every screen.

The region above the Menu Selection Buttons is called the Active Area, which is available for the display of maps and imagery. This Active Area may be completely filled with imagery, or it may be subdivided into separate windows of varying function. Figure 3.1 shows two windows, the Overview Window and the Detail Image Window.



Standard Buttons (appear on every menu)

Main Menu return to the primary menu
Previous Menu return to the parent menu

Figure 3.1. The Graphics Menu.

The number and type of windows displayed may vary from menu to menu.

Main Menu Buttons

From the Main Menu, the user is able to access any of the command menus by clicking the trackball-connected cursor on the appropriate Menu Button. These buttons are presented in Figure 3.2. Following is a brief description of the purpose of each of the menu choices:

SELECT IMAGE: Clicking on this button presents a menu and screen that allows information on any stored image to be selected. The region of interest can be specified, as well as a set of image lines for display. From the map presented, the user can select a line and have information presented on it in the Message Window.

VIEW IMAGE: Through the use of this Main Menu Button, any stored image may be selected and displayed in detail.

MARINE-VUE: The MARINE-VUE menu provides the functions for setting marine radar characteristics.

EDIT FLIGHT PLAN: Before being able to receive any imagery, STAR-VUE must be set up for the type of sensor being used, and the desired flight coverages. The operator is able to specify the flight line coverages and several other sensor parameters.

RECEIVE DATA: The RECEIVE DATA menu contains all the functions necessary to receive downlinked imagery data into planned flight lines. This includes functions such as selecting the flight line to be received and starting and stopping recording data.

UTILITIES: This Main Menu Button activates the sub-menu, which allows the operator to perform various types of system functions, such as managing received data.

Standard Buttons

In the lower right hand corner of each display screen are Standard Buttons. These buttons are PREVIOUS MENU and MAIN MENU. Their purposes are as follows:

PREVIOUS MENU: Clicking on this Menu Button results in the current menu being exited and the menu that it was entered from being displayed. This provides a way for the user to get out of a menu without having to perform any of the functions in that menu.

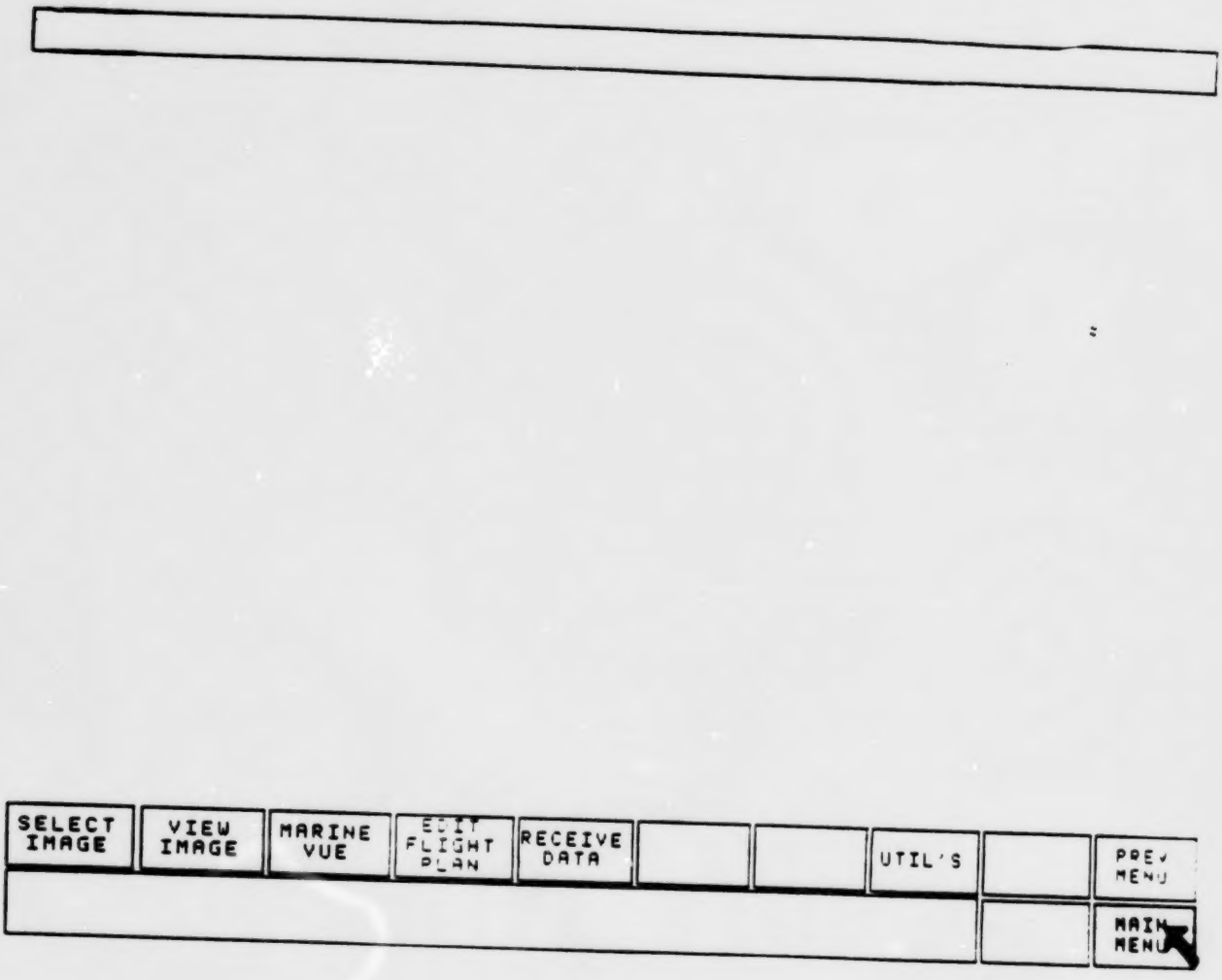


Figure 3.2. The Main Menu.

MAIN MENU: Clicking on this button from any menu causes the current menu and screen to be replaced by the MAIN MENU described in Section 1.0. This is provided as a short and simple means to get back to the main set of options, the MAIN MENU.

Other Selection Methods

In addition to the panel of menu buttons, there are pop-up menus. They are displayed within the Active Area, and are overlaid on the map/imagery (Figures 3.3) only when they are needed.

One of the problems identified through shipboard testing was the difficulty entering flightline coordinates into the system -a keyboard was required! Since one of the design goals of STAR-VUE was to make the system routinely operable without access to a keyboard, a new method of data entry was implemented. This was done using the trackball and a new feature, the pop-up keypad (figure 3.4)!

Each pop-up menu or pop-up keypad has a title at the top, and the title reflects the type of information listed or required in the menu/keypad. In addition, the CONFIRM and CANCEL buttons are standard. The CONFIRM is used to confirm the selection/entry by the operator. The CANCEL button is used to cancel the operation. If there are too many items to be displayed in the pop-up menu, the SCROLL UP and SCROLL DOWN buttons will also be present in pop-up menus so that the operator can access the rest of the items. The operator may use the SCROLL DOWN button to display items that are further down the list. If the end of list has been reached, a message will be displayed in the Message Window to say so. The SCROLL UP button performs just the opposite function from the SCROLL DOWN button.

There are two types of pop-up menus. The first type allows the operator to select one of the many selections listed in the pop-up menu. To make a selection, the operator moves the cursor until the tip of the arrow cursor rests on the item and clicks on the trackball's button. The selection would be highlighted. If the operator selects another item before it is confirmed, the previously selected item now becomes unselected. The pop-up menu would disappear after the selection/modification has been confirmed or canceled.

The other type of pop-up menu allows the operator to toggle the status of each item listed in the pop-up menu. The operator may toggle as many as required. The pop-up menu would disappear after the selection has been confirmed or cancelled.

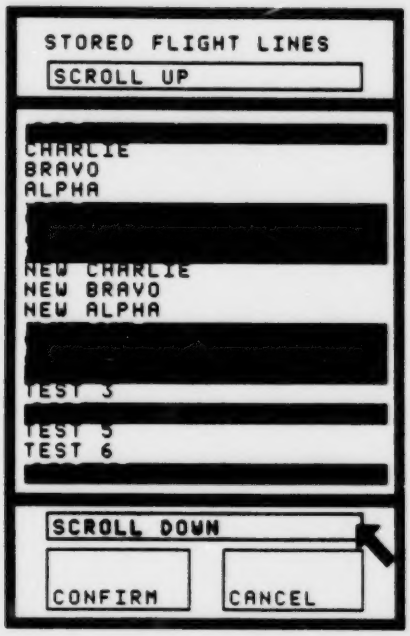


Figure 3.3. A Pop-Up Menu.

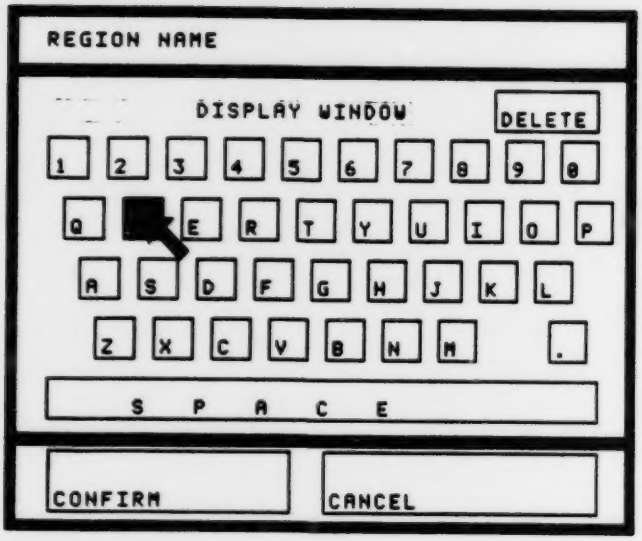


Figure 3.4. A Pop-Up Keyboard.

Pop-up keypads are used to enter text or numerical values. The layout of the keypad is similar to the layout of a typewriter. The operator may move the cursor into the appropriate keys and click the trackball's button.

The key entered is displayed in the window within the pop-up keypad. The DELETE key is used to erase the last key entered. The user may confirm or cancel the operation; the pop-up keypad would then disappear.

3.2 VIEW IMAGE

Several of the software changes that have been made to the STAR-VUE system have been incorporated into the View Image menu. The View Image functions have been described in previous reports to TDC. Simply, once an image line has been received, the user will likely want to examine it in detail. This is accomplished via the VIEW IMAGE screen.

Pressing the VIEW IMAGE button presents the screen shown in Figure 3.5. This screen contains two windows and the menu choices described below. The choices in the VIEW IMAGE menu allow a detailed examination of any portion of any received image. This menu presents the standard buttons described previously (PREVIOUS MENU, MAIN MENU), as well as the following ones:

SELECT IMAGE: Allows the selection of a flight line.

ROAM: This button allows the selection of a portion of the Overview Window to be displayed in a Detail Window.

ZOOM IN / ZOOM OUT: These two menu buttons change the size of the selection box used by ROAM. This allows the Detail Windows to show portions of the Overview Window at different levels of magnification.

DISPLAY DETAIL: This menu button places the contents of the ROAM box in the Detail Window, once the desired location and zoom level have been selected.

COURSE AND DISTANCE: This selection causes a new menu to be displayed for ship's navigation in ice.

New functions which have been added to the View-Image menu include the following:

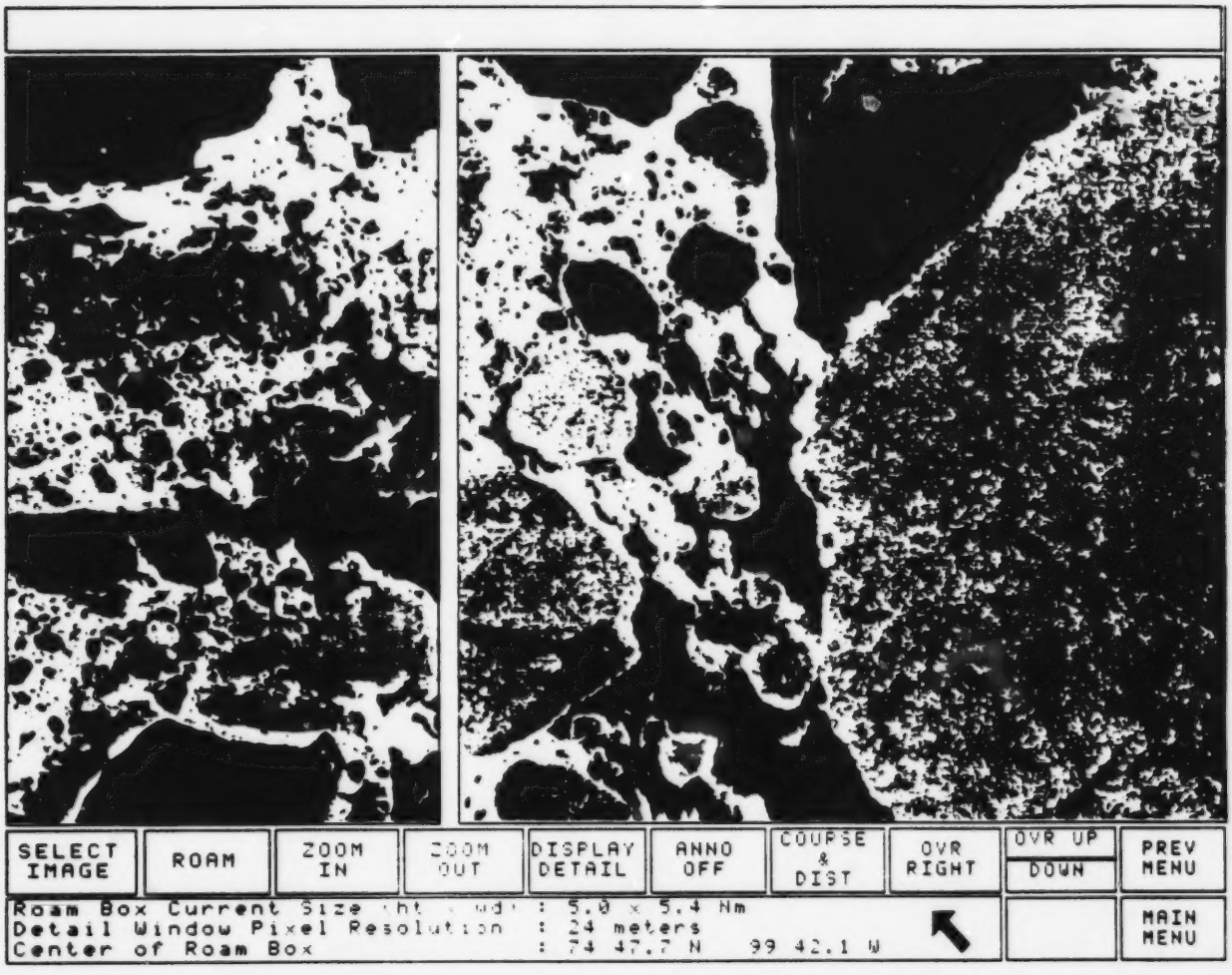


Figure 3.5. View Image Menu.

ANNO ON/OFF

The annotation that appears is in the form of an arrow that indicates the alignment of the imagery (the arrow points to the NORTH). This button can be clicked on to either hide or restore the annotation within the Detail Window (toggle action). This allows the annotation to be removed if it is thought to be hiding or obscuring any image features, and it may then be restored at a later time.

MODIFY LOOKUP TABLE

This selection provides the user with the capability to alter the color assignments for the imagery on the display monitor. This is described in more detail later.

SCROLL OVERVIEW UP/DOWN

Since the overview window may not accomodate the imagery from a full flight line, there are 2 buttons for scrolling. They are labelled OVR UP and DOWN. Upon selection of one of these functions, the overview imagery is pushed out the bottom or top to make room for some imagery that did not previously fit into the window. After the scrolling is complete, about 80 percent of the window will be taken up by imagery that was "scrolled in", unless the end of the flight line imagery was reached.

3.3 EDIT FLIGHT PLAN

Several modificatons have been made to the EDIT FLIGHT PLAN menu which is used to enter or delete planned coverages (flight lines). Once this menu is selected, the map last displayed and the flight line coverage boxes for both planned as well as received coverages are drawn (Figure 3.6).

The panel of buttons contain the Standard Buttons (PREVIOUS MENU and MAIN MENU), as well as those described in the following sections:

SELECT IMAGE

The SELECT IMAGE button can be used to display another map. This button is included so that the operator may change the scale or the centre of the map easily.

SET DEFAULT PARAMETERS

This is used to enter the default sensor parameters for all the flight courses that are subsequently entered. This includes the sensor type, near range, far range, line

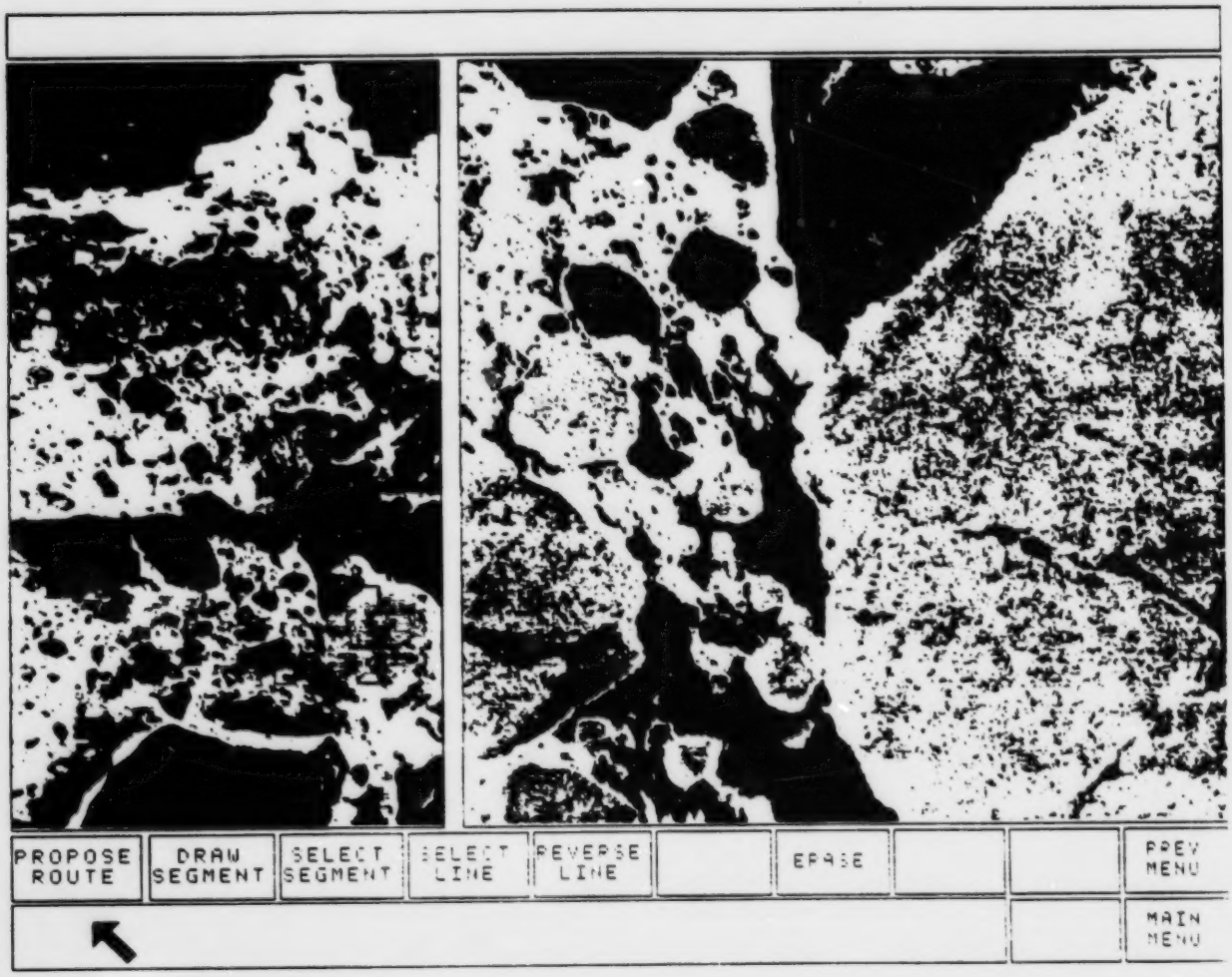


Figure 3.6. The Edit Flight Plan Menu.

length, inverted or not, average factor and pixel size. A pop-up menu with all the values for default parameters (new feature) will be displayed on the right side of the screen (Figure3.7).

The sensor type is either STAR-1, STAR-2, or SLAR radar. Near range and far range are the distances measured in nautical miles. The line length is the number of pixels across. The pixel size is measured in meters (assumed to be square). The average factor is the number of raw lines and pixels which have been averaged to obtain one pixel.

The user may select the item to be changed in the pop-up menu, and this will cause another pop-up menu/keypad to be displayed on the left-hand side so that the operator may enter a new value (Figure 3.8). The operator may change the parameters in any order and as many times as necessary. If a new value has been confirmed in the pop-up menu/keypad on the left side, the new value will be displayed in the pop-up menu on the right-hand side (Figure 3.9). After all the required changes have been made, the operator may confirm the operation on the pop-up menu with the CONFIRM button. If the operator does not wish to make the changes, then pressing the CANCEL button will cause the pop-up menu to disappear without changing any stored parameters.

Whenever an image coverage box is created, the default parameters will be copied; it then becomes part of the flight line parameters. The operator may change the information for individual coverages later, if necessary.

LIST STORED FLIGHT

The LIST STORED FLIGHTS button provides the ability to remove or include flight lines being displayed on the map.

ENTER FLIGHT COURSE

Once this new function button is pressed, a pop-up menu will be displayed on the right side of the screen (Figure 3.10). The operator has to enter the name, the starting and ending lat/long, of the aircraft (i.e., two points) and the look direction.

The name is the name of the flight line. The maximum number of characters (including blanks) is twenty-three. The lat/long are the positions of the aircraft. The look direction is (either LEFT or RIGHT) the side which the radar is sensing.

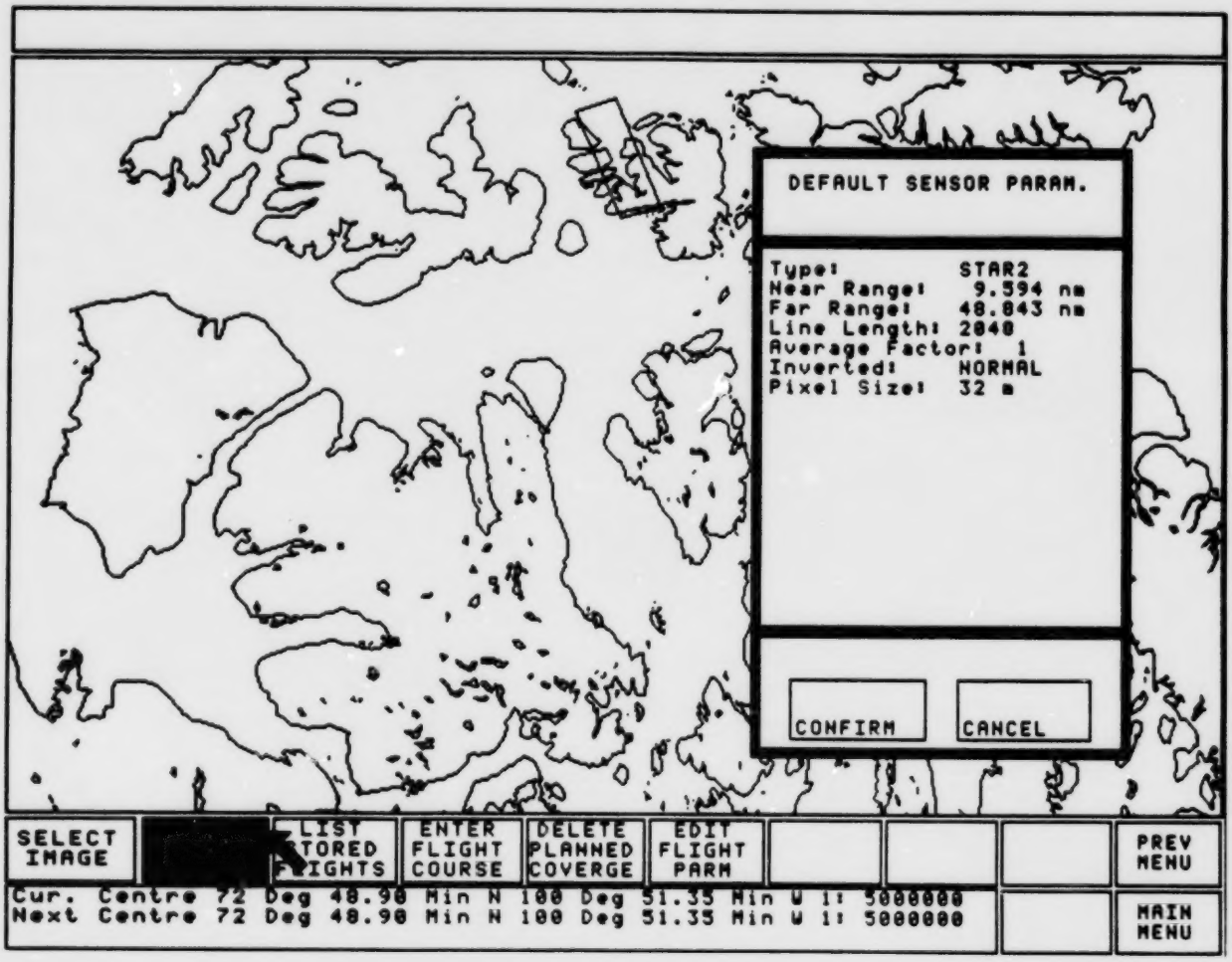


Figure 3.7. A Popu-Up Menu Showing Default Parameters.

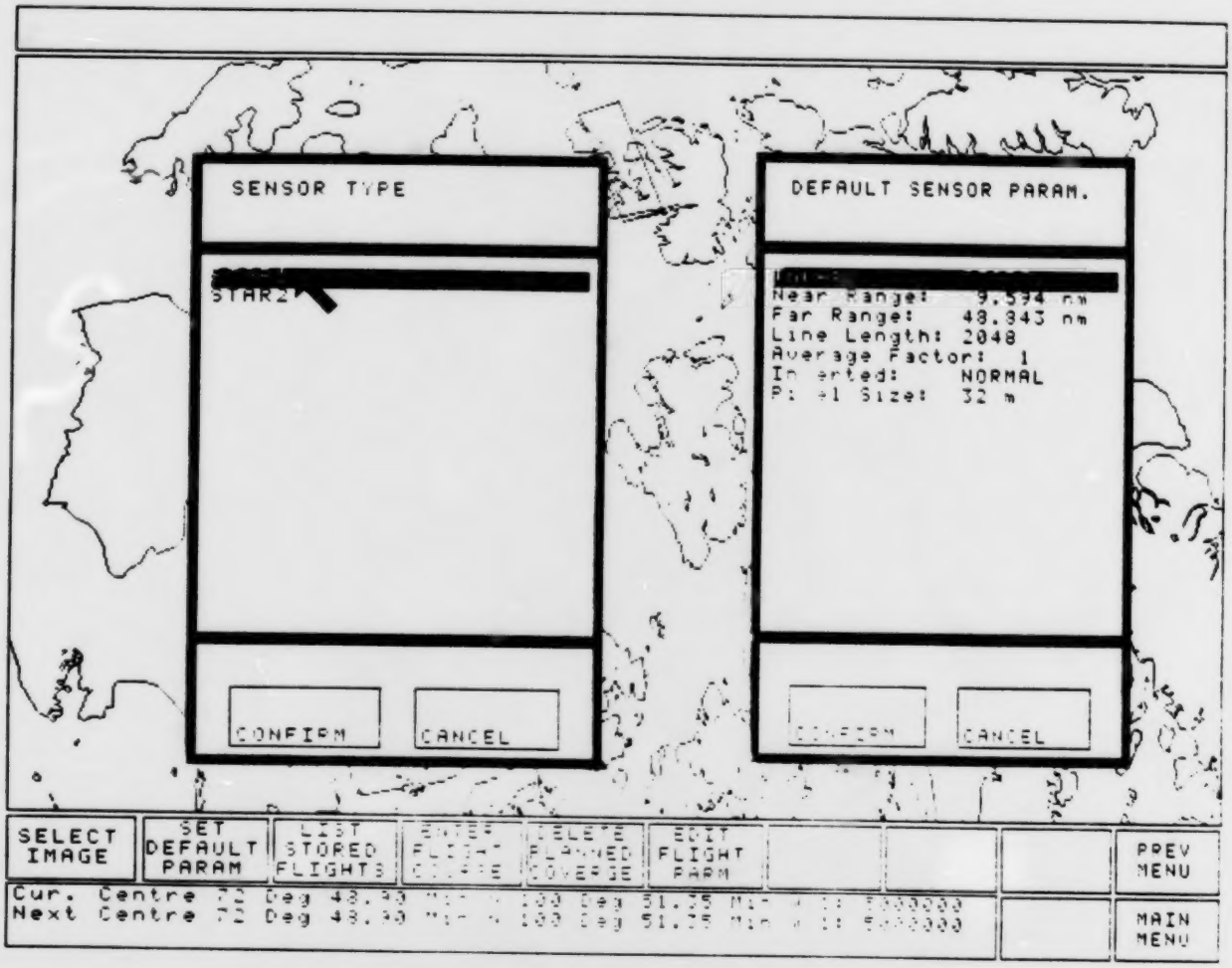


Figure 3.8. Entering a New Value on the Left Pop-Up Menu.

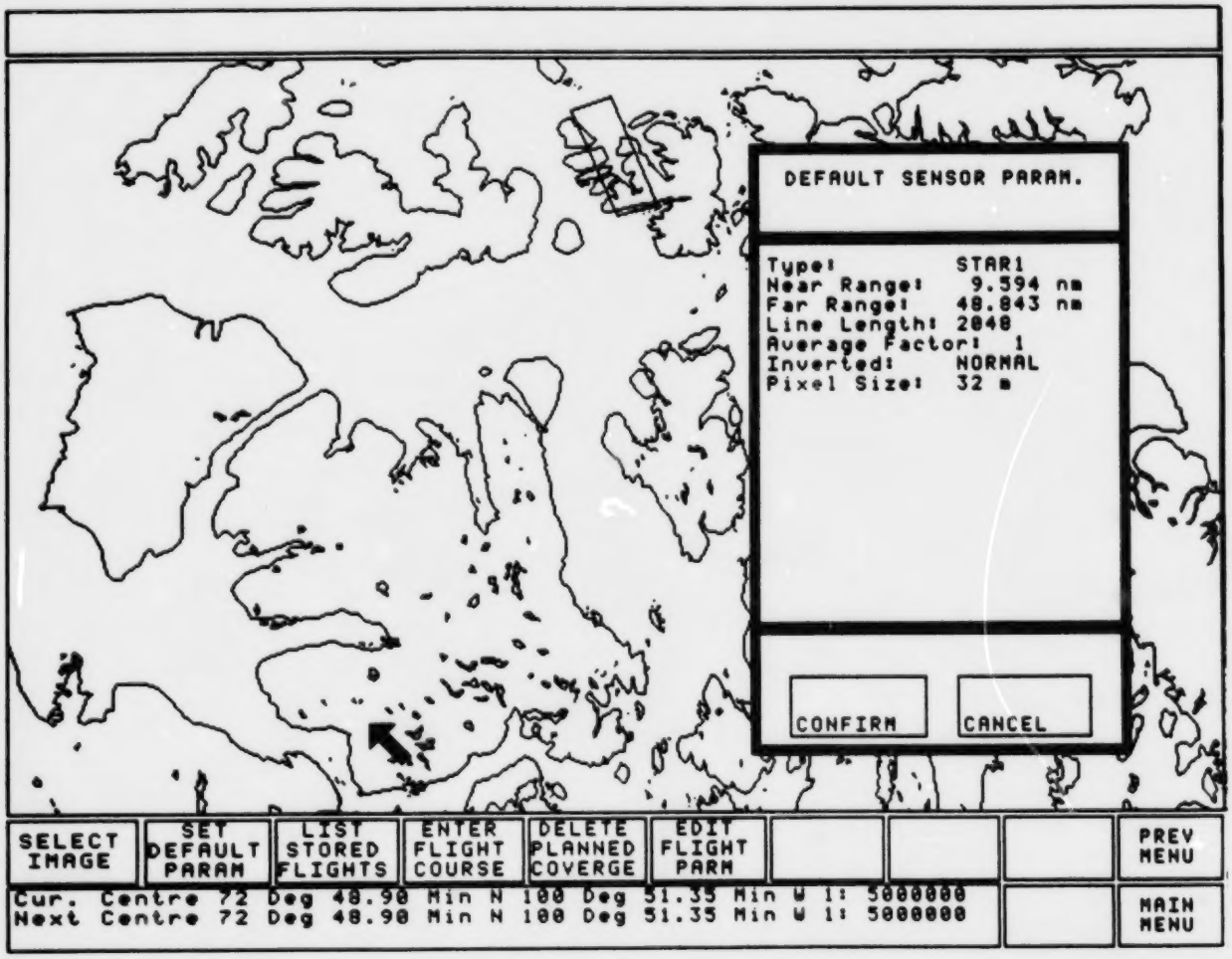


Figure 3.9. Parameter Being Updated in the Pop-Up Menu.

Only one parameter can be entered at a time, and they can be entered in any order. For example, if the user picks the flight line name in the pop-up menu, this will cause a pop-up keypad to be displayed on the left side. The user may then enter the name (Figure 3.11). If the name is confirmed in the keypad, the name entered will be displayed on the pop-up menu on the right side of the screen, and the keypad on the left will disappear (Figure 3.12).

The format for inputting lat/long is the degree followed by a space and then followed by the decimal minute, a space and direction (e.g. 104 10.5 W) (Figure 3.13). The lat/long coordinates entered must be within the boundaries of the world map. Otherwise, the user will be notified.

After all the parameters have been entered and confirmed, the pop-up menu will disappear, and the program will copy all the default parameters calculate the corresponding image coverage area and draw it on the screen. (Figure 3.14).

DELETE PLANNED COVERAGES

This button is used to delete the planned coverage selected. The operator should select the flight line before using this button. A flight line can be selected by moving the cursor to the desired flight line and clicking upon the trackball. The selected flight line will be highlighted, and the corresponding information is displayed in the message window (Figure 3.15).

Once this button is pressed, a pop-up menu is displayed on the screen to confirm the operation (Figure 3.16). If the operation is confirmed, the planned coverage will be deleted and the flight line coverage is removed from the map.

Only planned coverages can be deleted with this button. Received data must be deleted via the new function - MANAGED RECEIVED DATA.

EDIT FLIGHT PARAMETERS

This new button allows the user to modify the parameters of the selected flight line. Both planned and received flight lines can be selected. A flight line can be selected by moving the cursor into the box and clicking on the trackball button once. If the selected flight line has already been received, a pop-up menu will be displayed to confirm before the operator can proceed (Figure 3.17). A pop-up menu with all the parameters of the corresponding coverage will be displayed on the right side of the screen (Figure 3.18). The user may select the item to be changed in the pop-up menu, and this will cause another pop-up menu/keypad to be displayed on the left-hand side so that the user may enter a new value for the corresponding item. If the value is confirmed in the

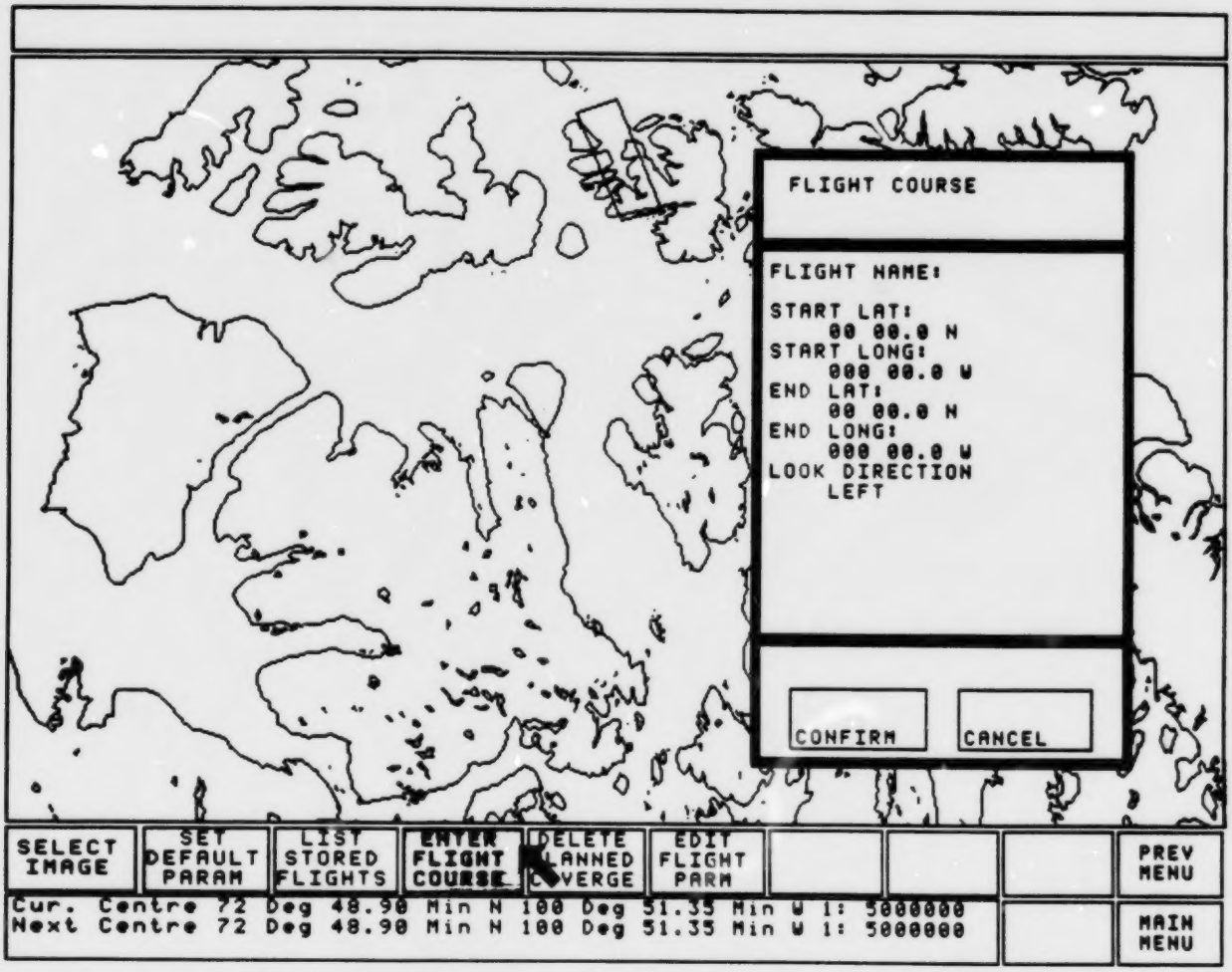


Figure 3.10 Pop-Up Menu for Enter Flight Course.

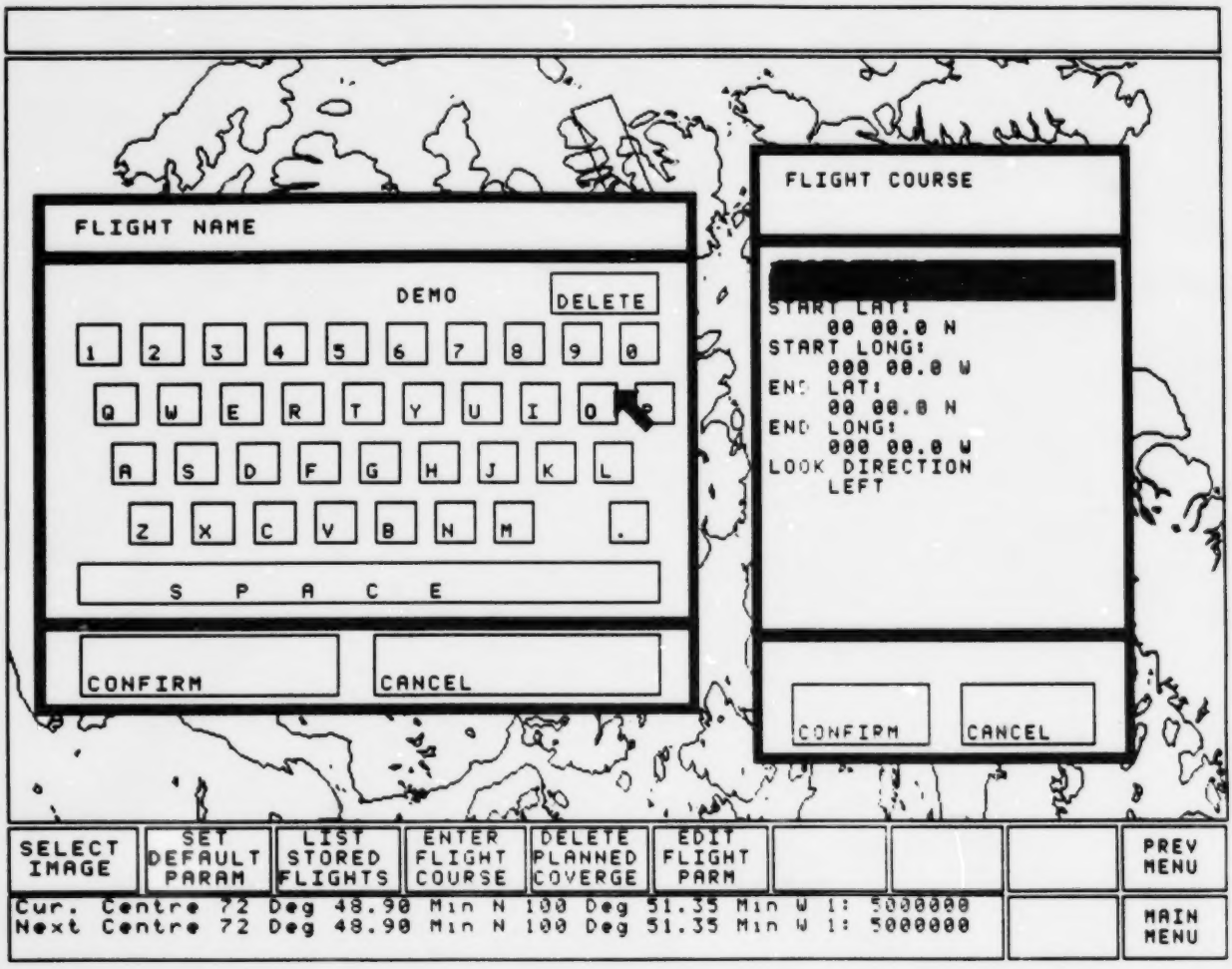


Figure 3.11 Entering the Flight Line Name.

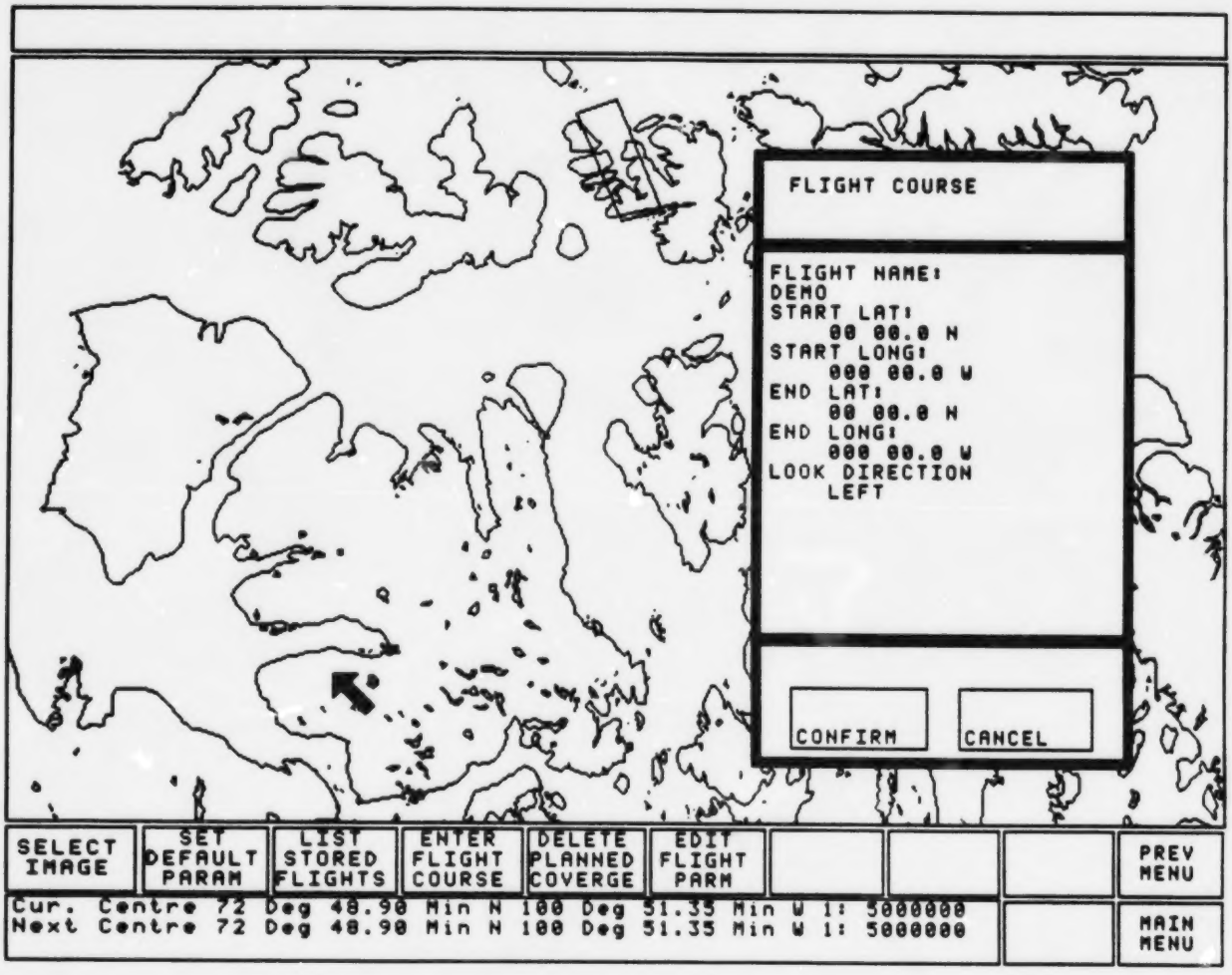


Figure 3.12 Flight Line Name Being Displayed in the Pop-Up Menu.

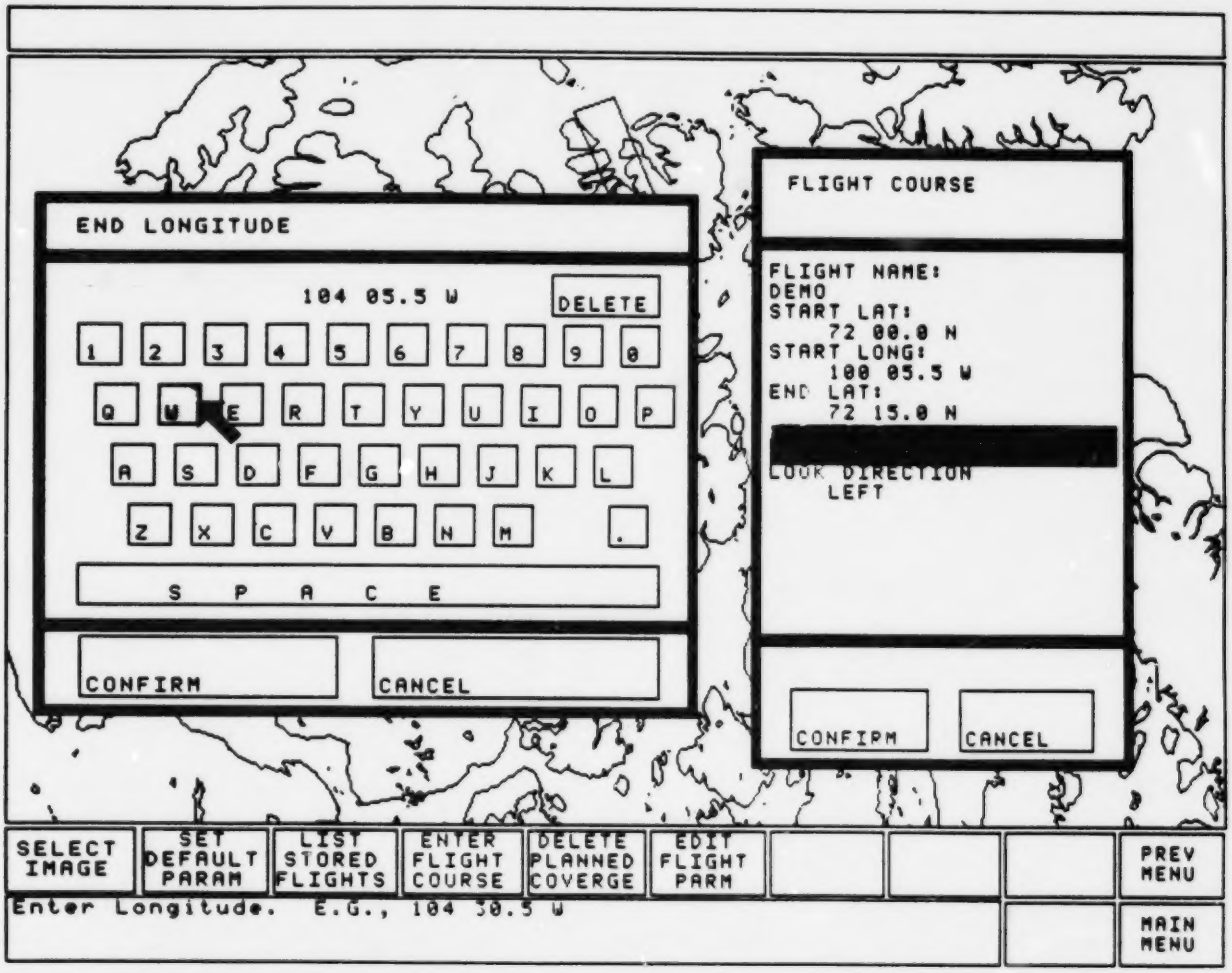


Figure 3.13 Entering the Longitude Value.

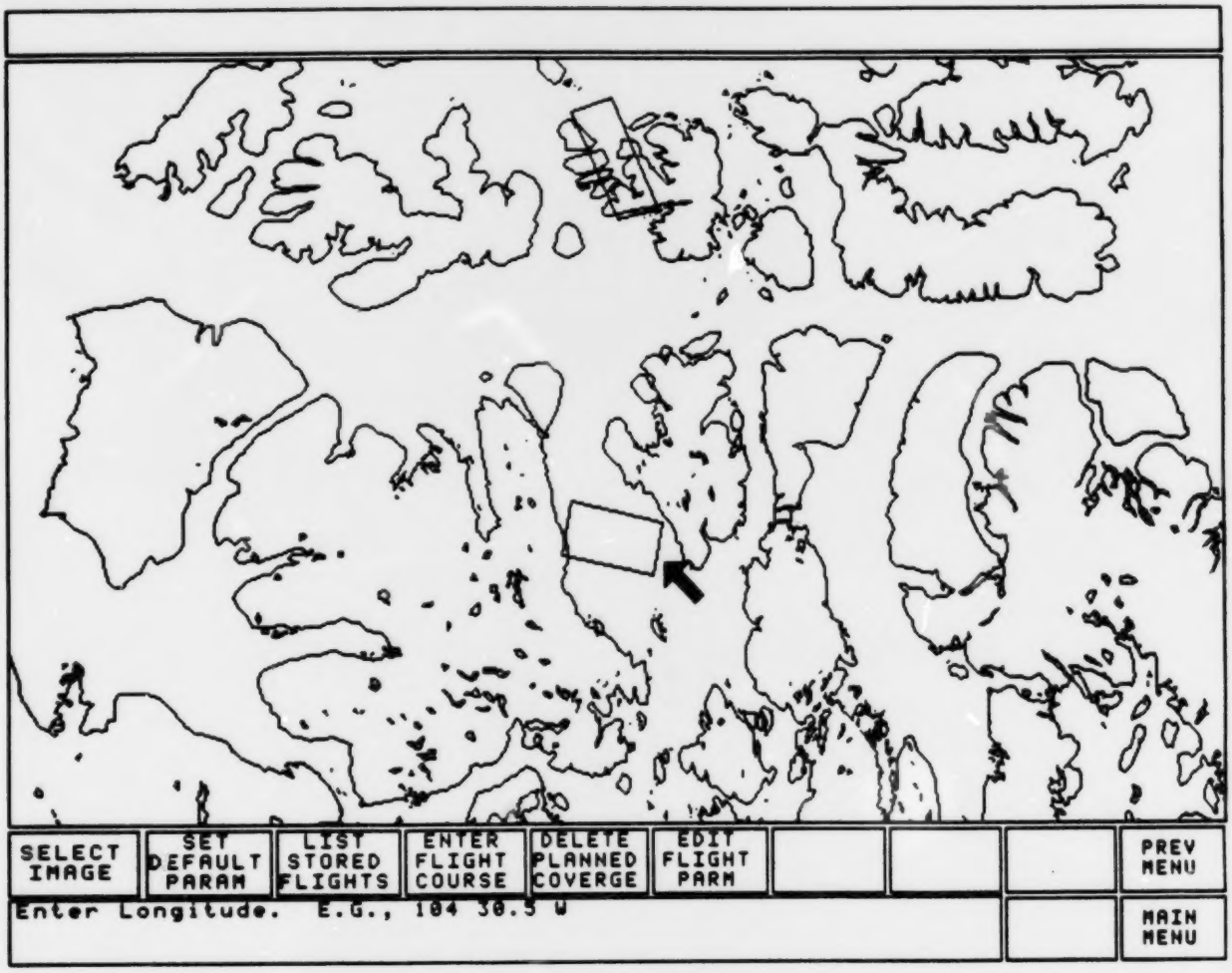


Figure 3.14 A New Flight Icon Is Included.

menu/keypad, the new value entered will be updated on the pop-up menu on the right side of the screen, and the pop-up menu/keypad on the left will disappear. Since there are more parameters than the pop-up menu can display at once, the user may need to use the SCROLL UP and SCROLL DOWN buttons to display the parameter needed (see Figure 3.19).

The coordinates for both the flight course and flight coverage are displayed. If the coordinates of the flight course or look direction are entered, the program will compute the coordinates of the coverage again, and the position of the flight line on the map will be updated to reflect the changes.

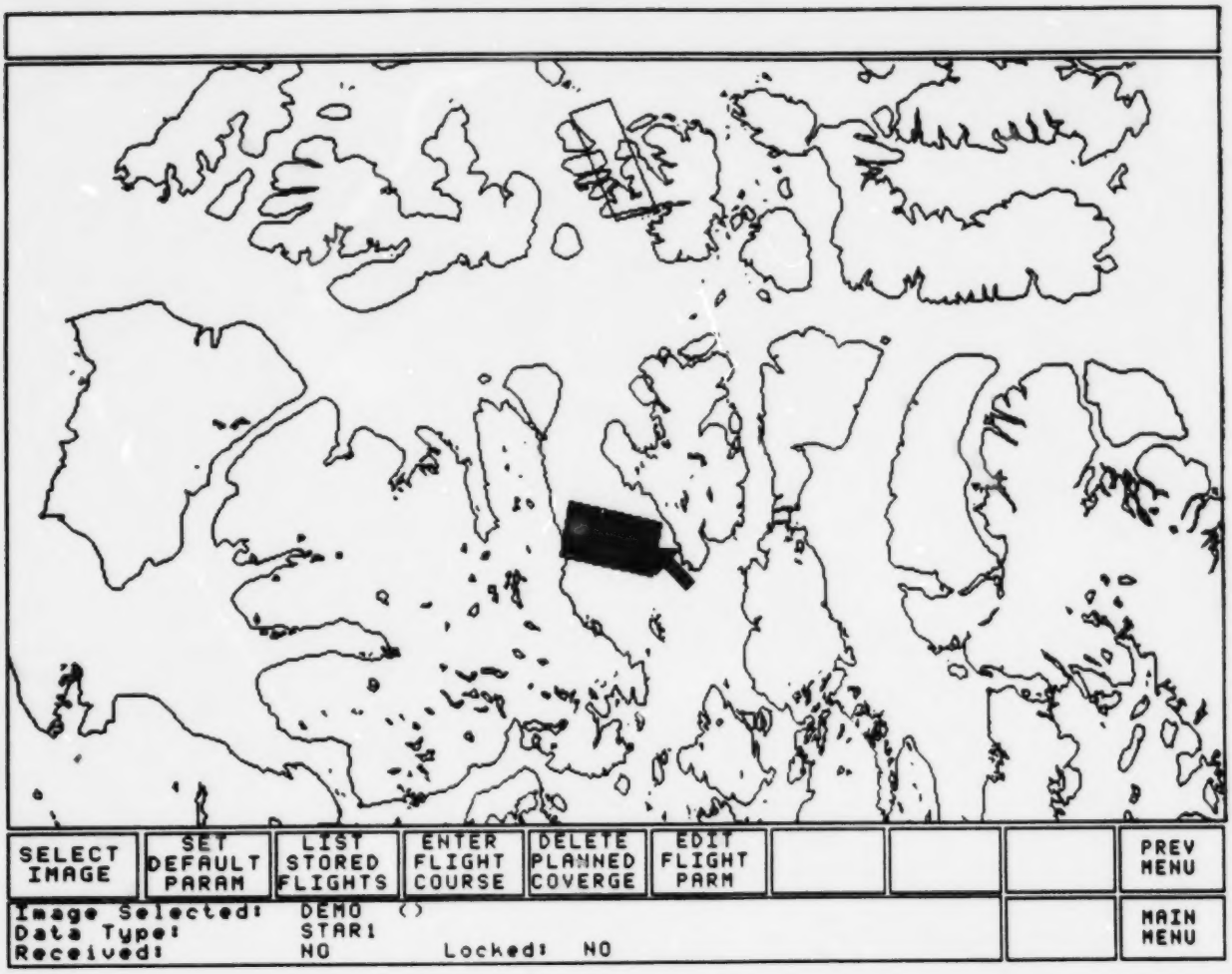


Figure 3.15 Selecting a Planned Coverage.

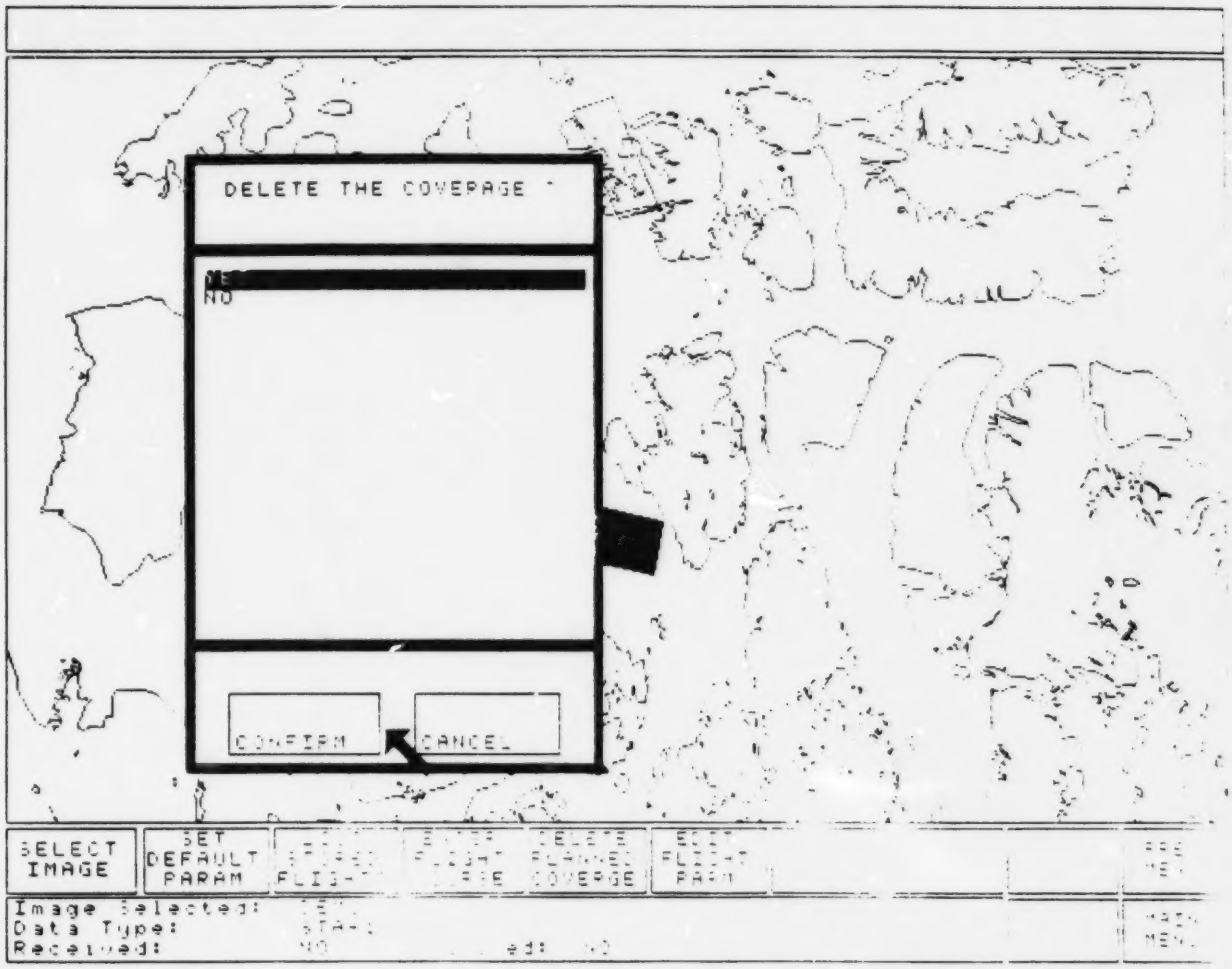


Figure 3.16 A Pop-Up Menu to Confirm the Deletion.

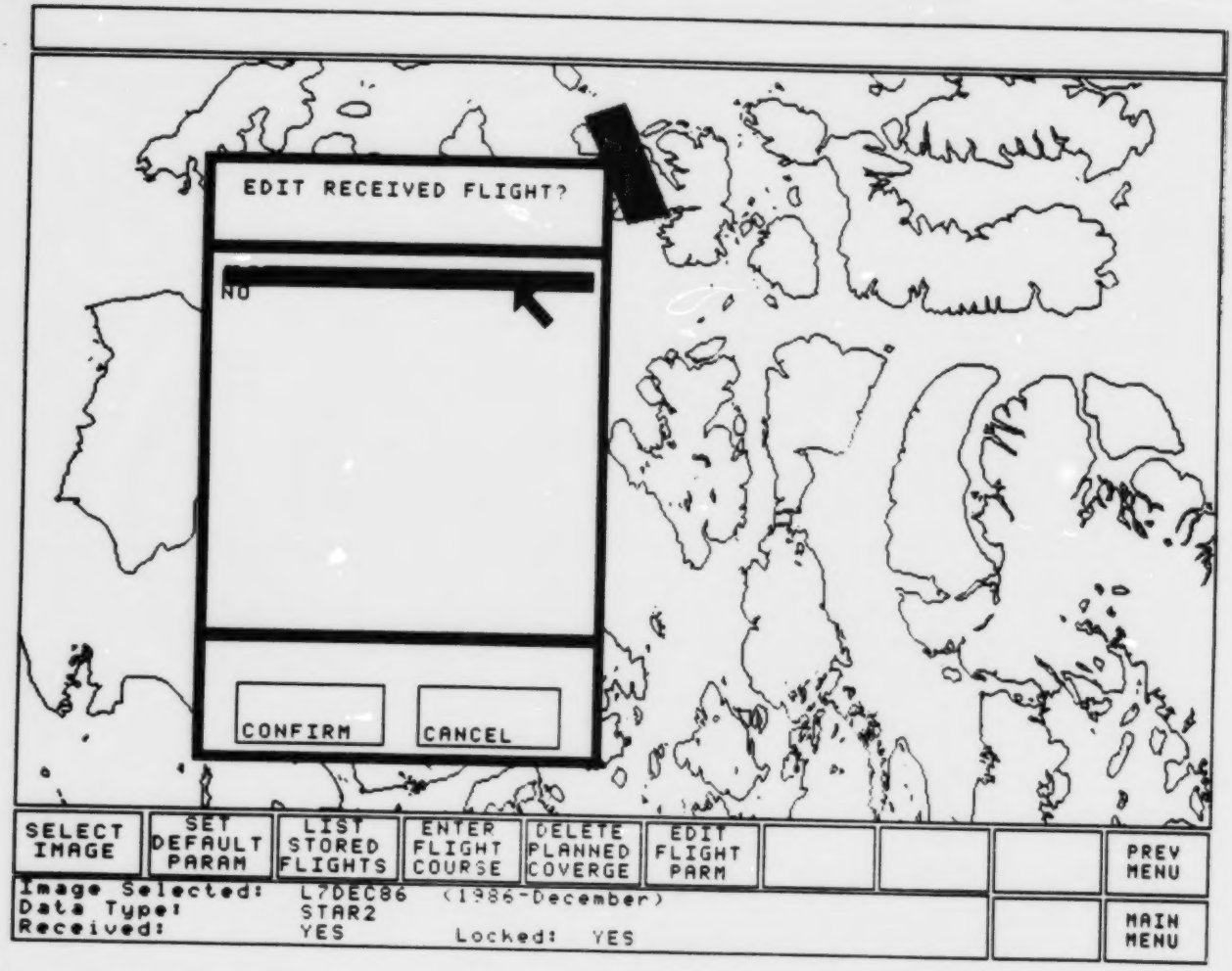


Figure 3.17 Confirming Before Editing a Receive Flight Line.

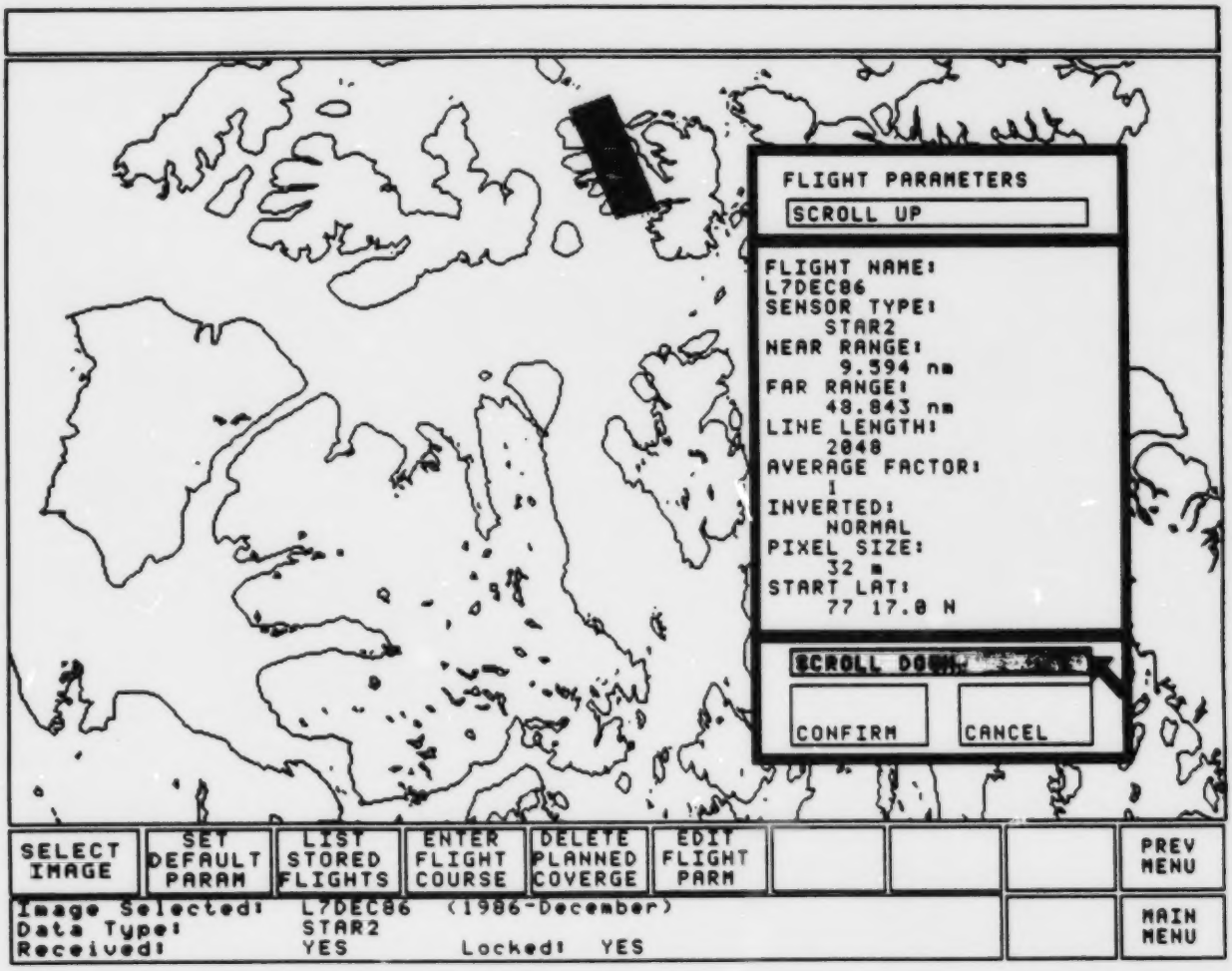


Figure 3.18 The Pop-Up Menu for Edit Flight Parameters.

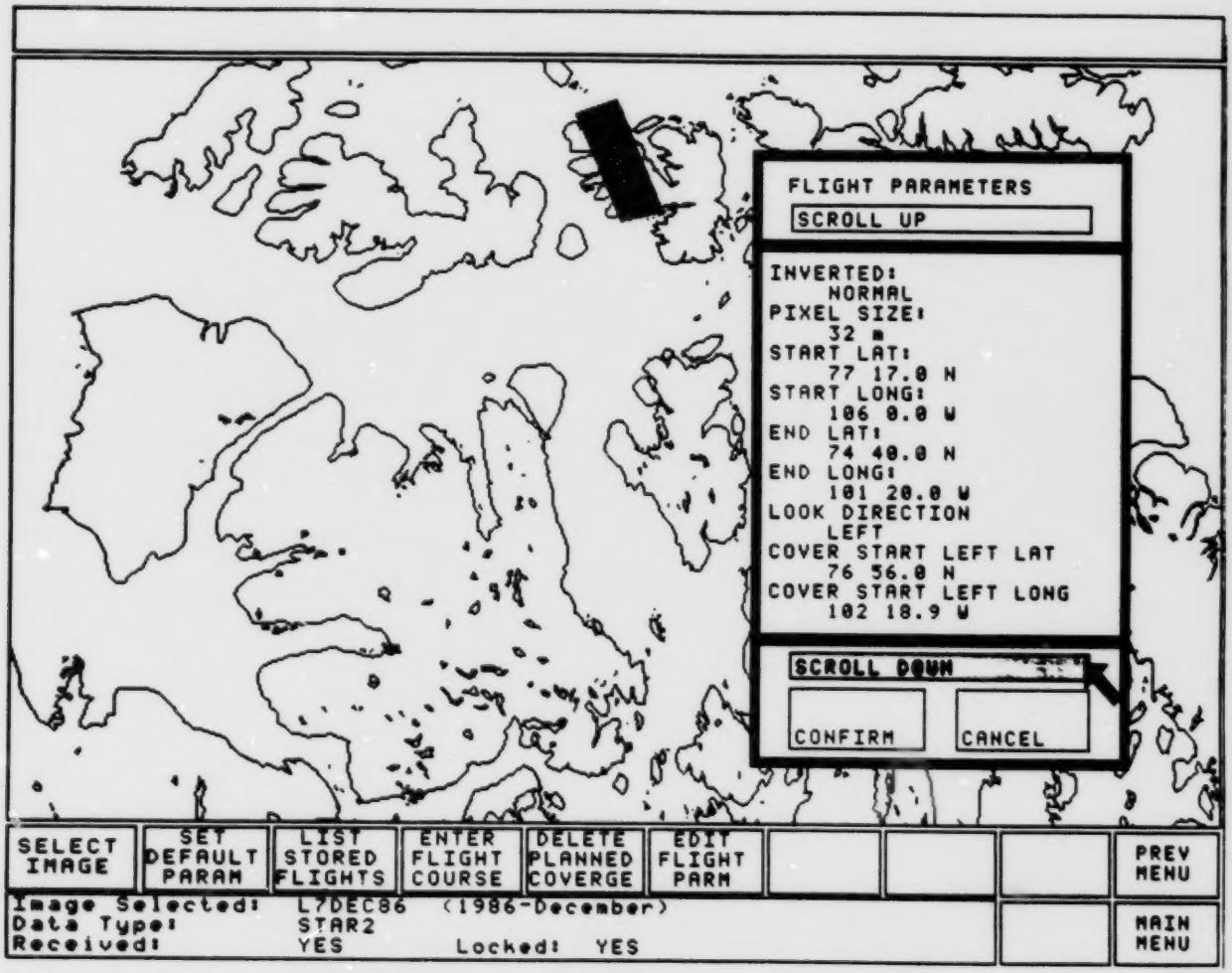


Figure 3.19 Scroll Down the Parameter List.

3.4 RECEIVE DATA

This menu (see Figure 3.20) contains the functions necessary to receive downlinked imagery data into a planned flight line. Because the transmissions from the INTERA STAR-1 radar and both the INTERA and AES SLAR's are not annotated (at least for the 1986-87 shipping season), this function was, and will be required in the near future. A great deal of effort has therefore gone into its design and recommendations resulting from shipboard testing on the M.V. Arctic have been incorporated. Preparations for receiving data, including creating the planned flight information, is done through the EDIT FLIGHT PLAN functions.

For receiving a planned flight after entering the flight plan, etc., the general procedure is as follows:

1. Through the SELECT IMAGE function under the MAIN MENU, position the cursor over the flight line icon to be received and press the trackball button. The selected flight line is now the current flight line.

2. Select RECEIVE DATA under the MAIN MENU.

3. Select the SET RECEIVE FILE function. This instructs the system to receive the next downlinked imagery into the current flight line (last one selected).

4. Select the RECEIVER STOPPED function to start the receiver system. Note that the button label changes to RECEIVER STOPPED.

5. Select the WATERFALL STOPPED function to start the waterfall display. Note that the button label changes to WATERFALL STARTED. This action will cause incoming data or test pattern to be shown on the display monitor as they are received.

6. When it is determined that the aircraft has reached the start of the prescribed flight line, select the DATA RECORD STOPPED button to begin writing the imagery to the computer disk. The button will then read DATA RECORD STARTED.

7. When it is determined that the aircraft has reached the end of the flight line, turn off the recording of data by selecting DATA RECORD STARTED. The button will then read DATA RECORD STOPPED.

8. If the aircraft is to fly another flight line, the user must select a new file into which to receive the imagery. This is done by turning off the receiver system by selecting

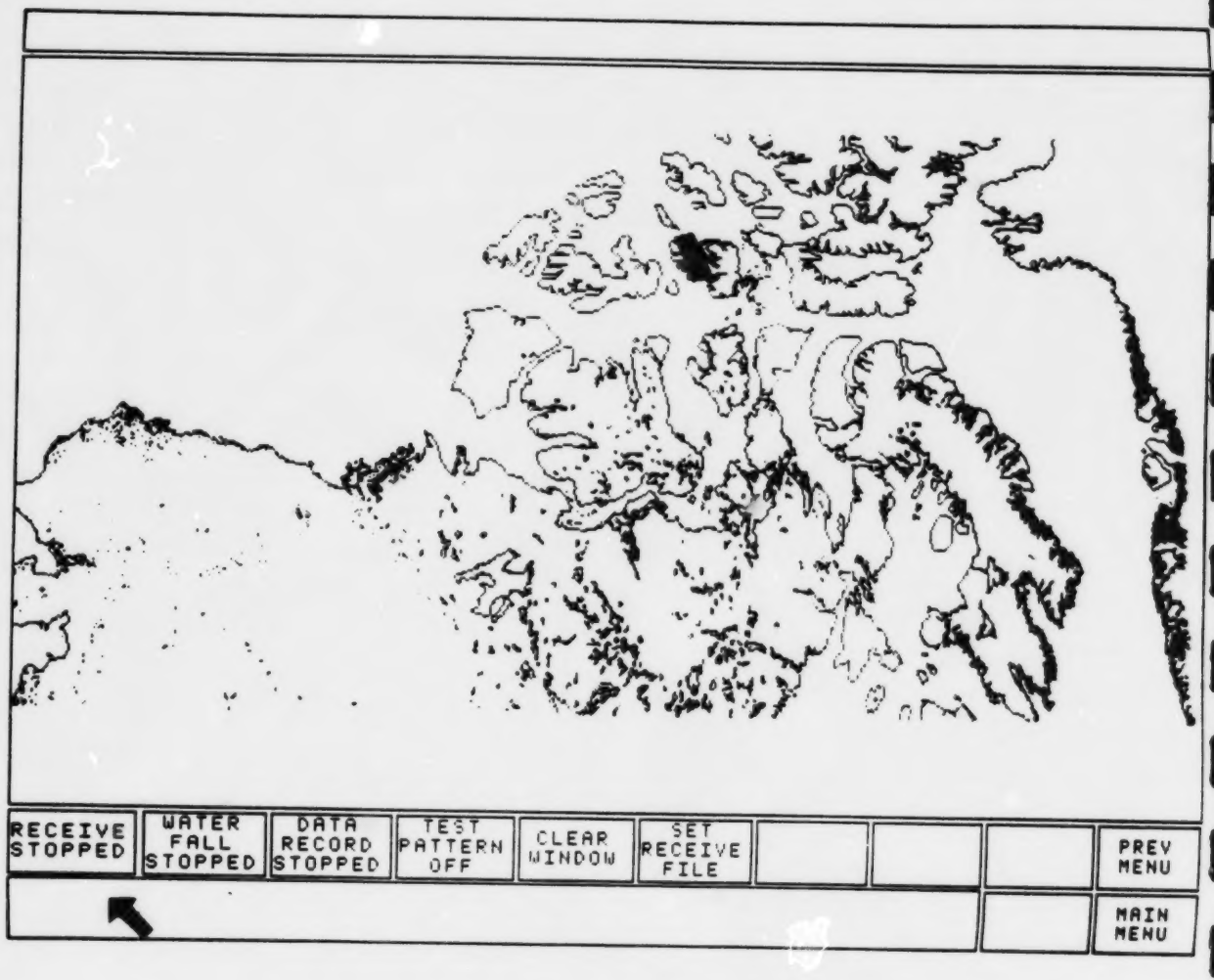


Figure 3.20 Receive Data Menu

RECEIVER STARTED, and then selecting the MAIN MENU function and repeating steps 1-7 for the new planned flight line.

While a line is being received, other received lines may be examined using the VIEW IMAGE button found on the MAIN MENU. If the operator returns to the RECEIVE DATA menu, the waterfall must be restarted in order to view the incoming imagery.

The individual functions are described in detail below.

RECEIVE STARTED/STOPPED

This function must be used to activate and deactivate the receiver system in the computer at the proper time. No imagery can be received unless this system has been started. When the RECEIVE STOPPED function is selected, the menu button changes to RECEIVE STARTED and the system readies the flight line to be received, the name of which appears in the Message Window. The flight line used is the one that was current at the time of the last invocation of the SET RECEIVE FILE function. Note that if the user selects SET RECEIVE FILE while the receiver system is started, no action takes place. However, if the system is stopped then restarted, the action then takes place and the current flight line will be the next one to be received. Every time the receiver is started, a pop-up menu is displayed (Figure 3.21) and the user must confirm that they wish to receive into the specified flight line. This measure is taken since it is possible to delete imagery by receiving new data into a flight line that has existing data in it. Note that this will still happen if the user confirms that they wish to do so.

WATERFALL STARTED/STOPPED

This function is used when the operator wishes to view any incoming data or test patterr on the display monitor as they are received. The menu button initially reads WATERFALL STOPPED. When selected, it changes to WATERFALL STARTED and any incoming data or test pattern are "cascaded" down the display. The cascading will cease and the menu button will then read WATERFALL STOPPED. Note that when the user leaves the RECEIVE DATA menu, the waterfall is automatically stopped.

DATA RECORD STARTED/STOPPED

This function controls the writing of the incoming imagery or test pattern to the computer disk file. However, no action is taken unless the status of the RECEIVE function is STARTED. The menu button initially reads DATA RECORD STOPPED. When selected, it changes to DATA RECORD STARTED and any incoming data are recorded. To stop the recording, select the DATA RECORD STARTED function. Normally, the

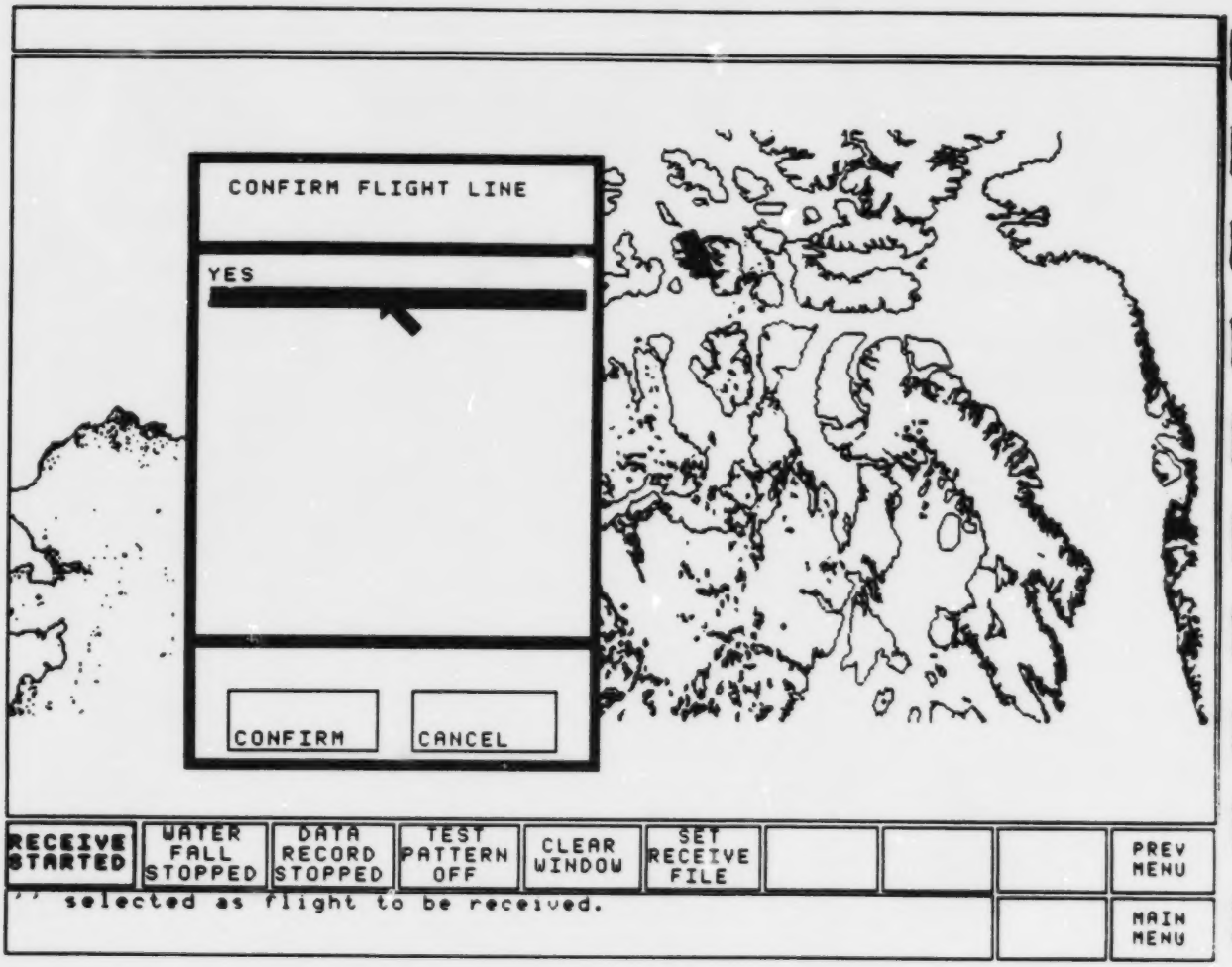


Figure 3.21 Confirm Flight Line.

recording should be started when the aircraft reaches start-of-line and should be stopped when the aircraft reaches end-of-line.

TEST PATTERN ON/OFF

This function allows the user to turn an interval test pattern on or off. The test pattern is used to test the complete receiver system, with the exception of the actual RF link. The initial condition of the test pattern is OFF. When the TEST PATTERN OFF function is selected, the menu button changes to TEST PATTERN ON and the test pattern is turned on.

CLEAR WINDOW

This function wipes the display clear of any imagery or test pattern data that is in the Active Area.

SET RECEIVE FILE

This function is used when the operator is ready to receive into a new planned flight line. The user must first select a flight line with the SELECT IMAGE function under the MAIN MENU. If the status of the receiver system is STARTED, then the user must stop the receiver and restart it sometime before starting the recording of data for the system to use that last file selected.

3.5 UTILS

Upon selecting this Main Menu item, the user is presented with a sub-menu that contains a number of utility functions that have been added to STAR-VUE or were modified as a result of this contract (Figure 3.22). These include:

HARD COPY: The user is able to produce a paper strip output of selected imagery.

GEOREFERENCE IMAGE: This function enables to the user to accurately register the imagery to the real world lat/long coordinates.

MODIFY LOOKUP TABLE: The user may change the color assignments of the imagery as it is shown on the display monitor to suit their needs and preferences.

EDIT DEFINED REGIONS: Background maps may be created and deleted for any region in the customer's geographical area.

MANAGE RECEIVED DATA: This heading contains functions that allow the user to perform some housekeeping tasks with the imagery data, such as archiving and restoring data.

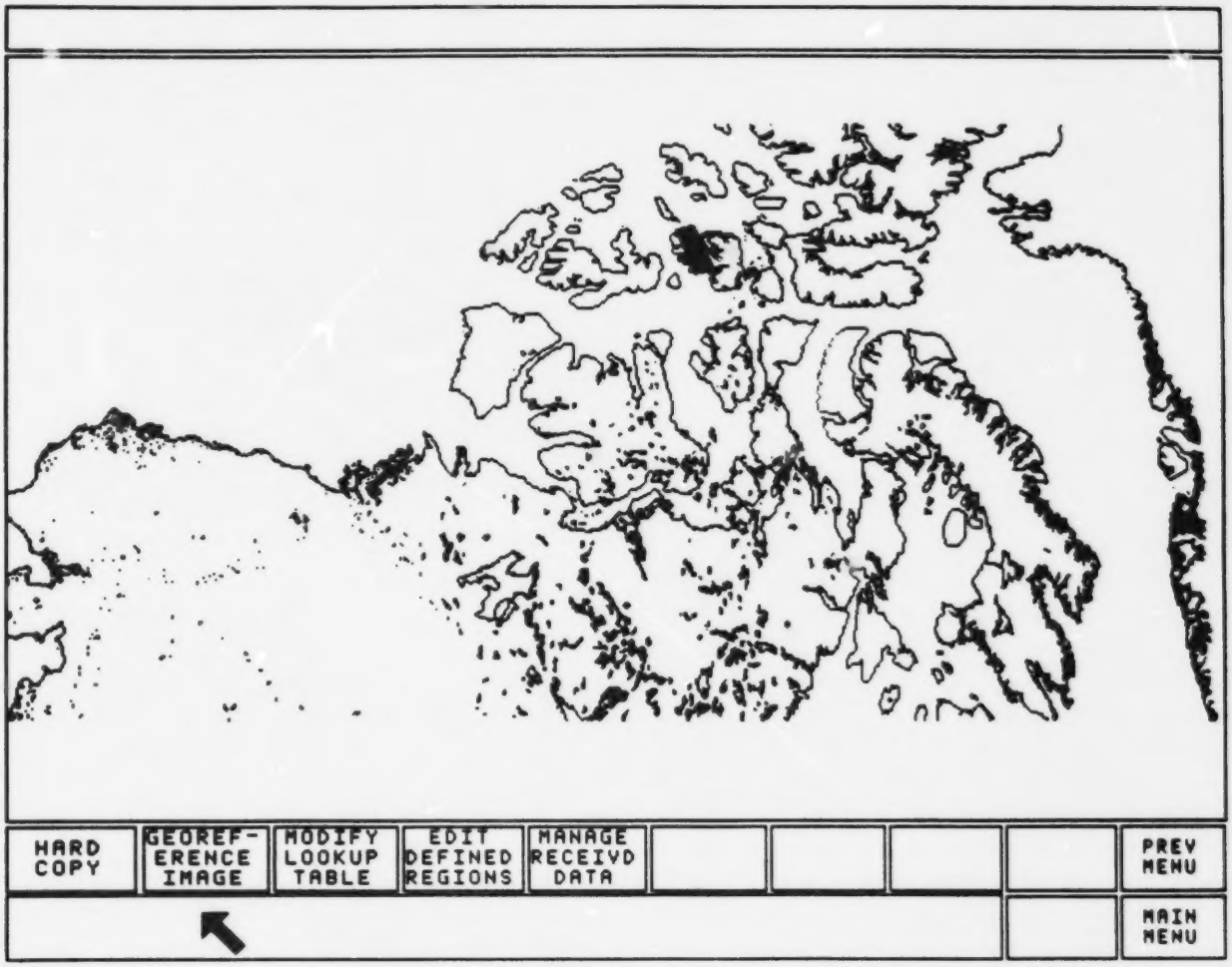


Figure 3.22 Utils Menu

3.6 HARD COPY

The Hard Copy menu contains functions necessary to produce a paper output of imagery (Figure 3.23). The user first selects either the current flight line, or a window of the display monitor. The actual printing is controlled through the use of the Start Hard Copy and Stop Hard Copy selections.

Full Flight Line
This selection will cause the system to make the current flight line the next item to be printed. No action is taken until selection of the Start Hard Copy function.

Full Screen
A "snapshot" of the display monitor is possible by selecting this function (Figure 3.24).

Detail Window
This function allows the user to print only the contents of the Detail Window.

Normal / Inverted Hardcopy
Many users of remote sensing data prefer to work with hardcopy negative transparencies. A new function was therefore added to STAR-VUE to allow the user to change the polarity of the hard copy. The initial button label reads NORMAL HARD COPY. Any hard copy function will produce a positive image. Selection of this function will causes the label to change to INVERTED HARD COPY and any subsequent hard copy will be produced as a negative image.

Set Fast/ Slow Replay
This is another improvement to the STAR-VUE system requested by shipboard users who wish to obtain a hardcopy print as quickly as possible after the imagery is downlinked. Quite often several prints are required. With this function, the user has the capability to produce hard copy at a faster rate (the normal mode is slow replay: button reads SET FAST REPLAY). When this function is selected, the menu label changes to SET SLOW REPLAY and any subsequent hard copying will be done in fast mode. Note that the Star-Vue system cannot perform any other functions while a fast hard copy is being done, as the computer is dedicated to this task. Note also that it is the operator's responsibility to ensure that the film speed on the EDO printer is compatible with the current replay speed on Star-Vue.

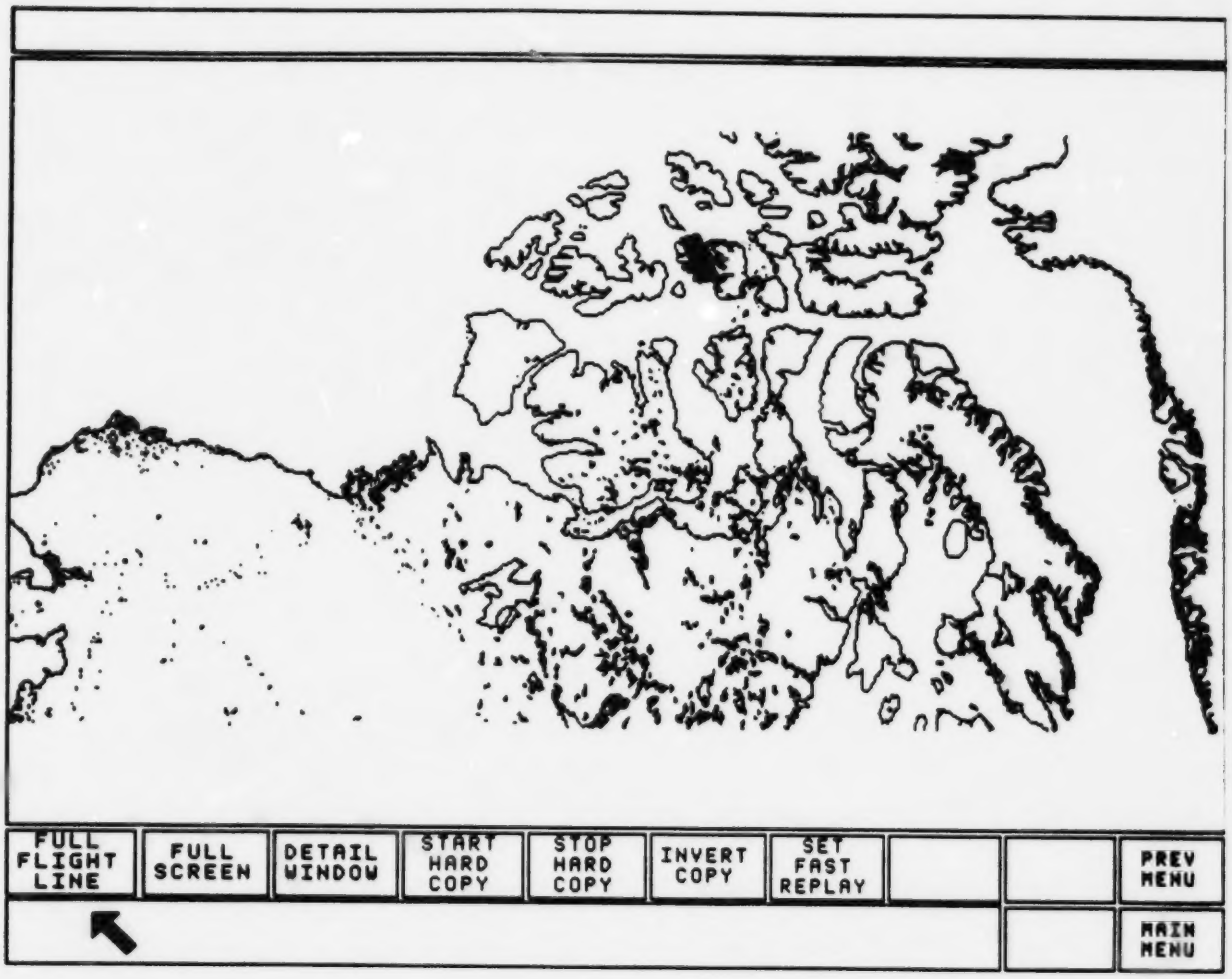


Figure 3.23 Hard Copy Menu

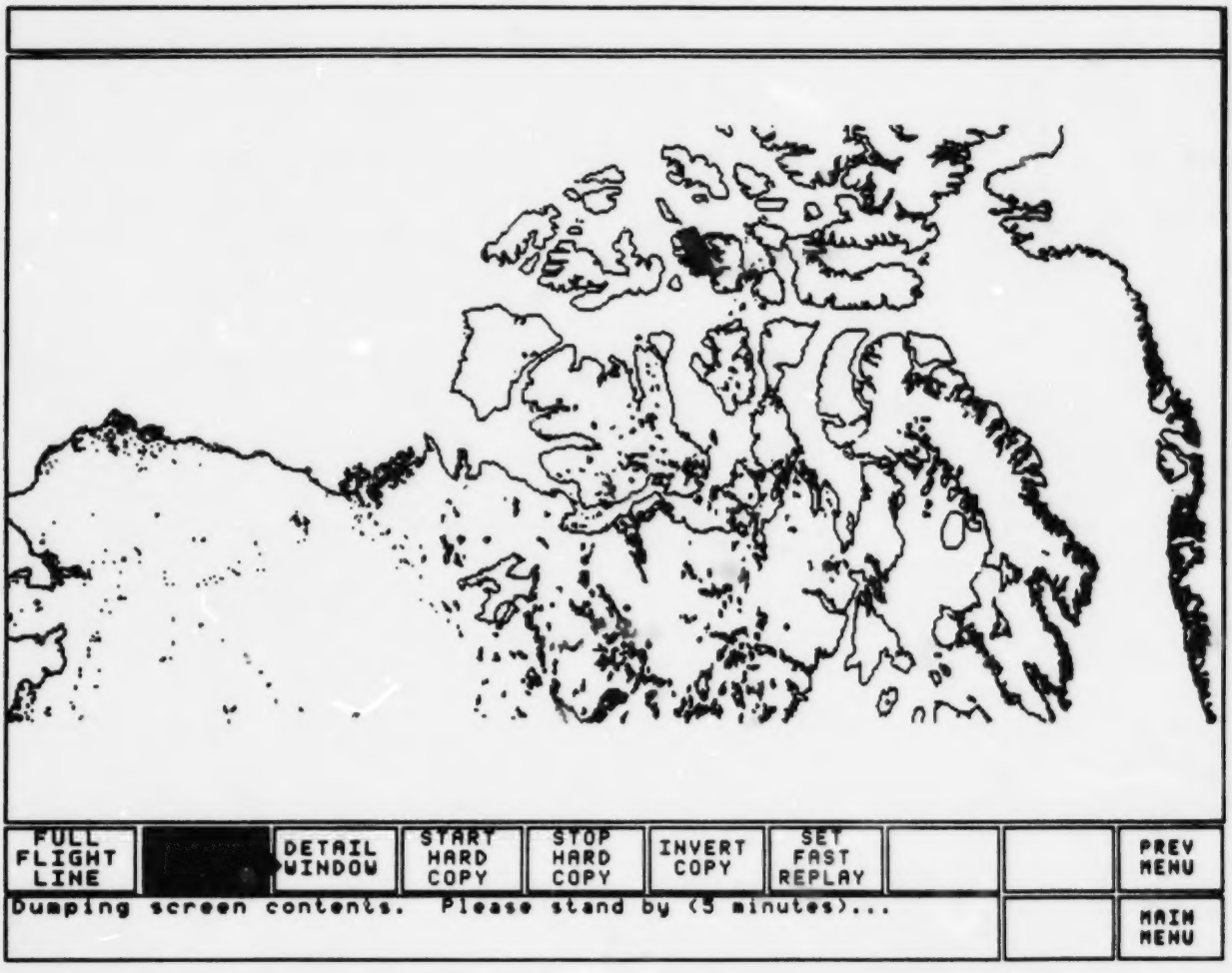


Figure 3.24 Wait For Dump

3.7 GEOREFERENCE IMAGE

In most cases, the lat/long position of a planned flight line closely corresponds to the real world position of the imagery received. However, an occasional error in the aircraft's flight plan or navigation system may result in the imagery being improperly registered to the planned lat/long position. For such cases, the new georeferencing function (Figure 3.25) may be used to accurately match up the real world lat/long position to the imagery received. This is possible only when there are identifiable features on the imagery whose exact lat/long positions are known.

The idea behind this function is that if the magnitude of error is known (for example, if it is determined that the the coordinates given by the system are in error by 30 minutes longitude and 10 minutes latitude), the system can then adjust its version of the flight line coordinates by the magnitude of error, thus correcting the error. This magnitude of error is computed by the system in the following way:

- The user identifies a feature on the imagery where the lat/long position is known. This may be a point of land, fast ice, or the ship if this information can be obtained from the ship's log at the time of imagery downlink.

- The user then tells the system, through a pop-up keyboard on the display monitor, the lat/long coordinates of the chosen point.

Since the system now knows both the correct lat/long coordinates of the chosen point as well as the coordinates that are in error, it can compute the magnitude of error. It can then use this error to correct the system's idea of the coordinates of the whole flight line, and not just those of the user-chosen point.

Simple mathematics dictate that by using one corrected reference point entered by the user, it is possible to shift (translate) the system's version of the flight line coordinates by the magnitude of error. This method will work if the error was originally introduced by the aircraft flying the desired course parallel to the planned flight line, but will not give good results if other kinds of errors are present (for example, slightly wrong course flown). In such cases, it is necessary to enter two reference points in order to get the best results from this function. With two known reference points, the system can compute the new coordinates by doing both translational and rotational computations on the old coordinates. Therefore, for best results, the user should enter two reference points for the system to use to recalculate the flight line corodinates. Note that the

system recalculates the coordinates of the four corners of the flight line so that all points on the imagery that are subsequently selected will give the correct lat/long position.

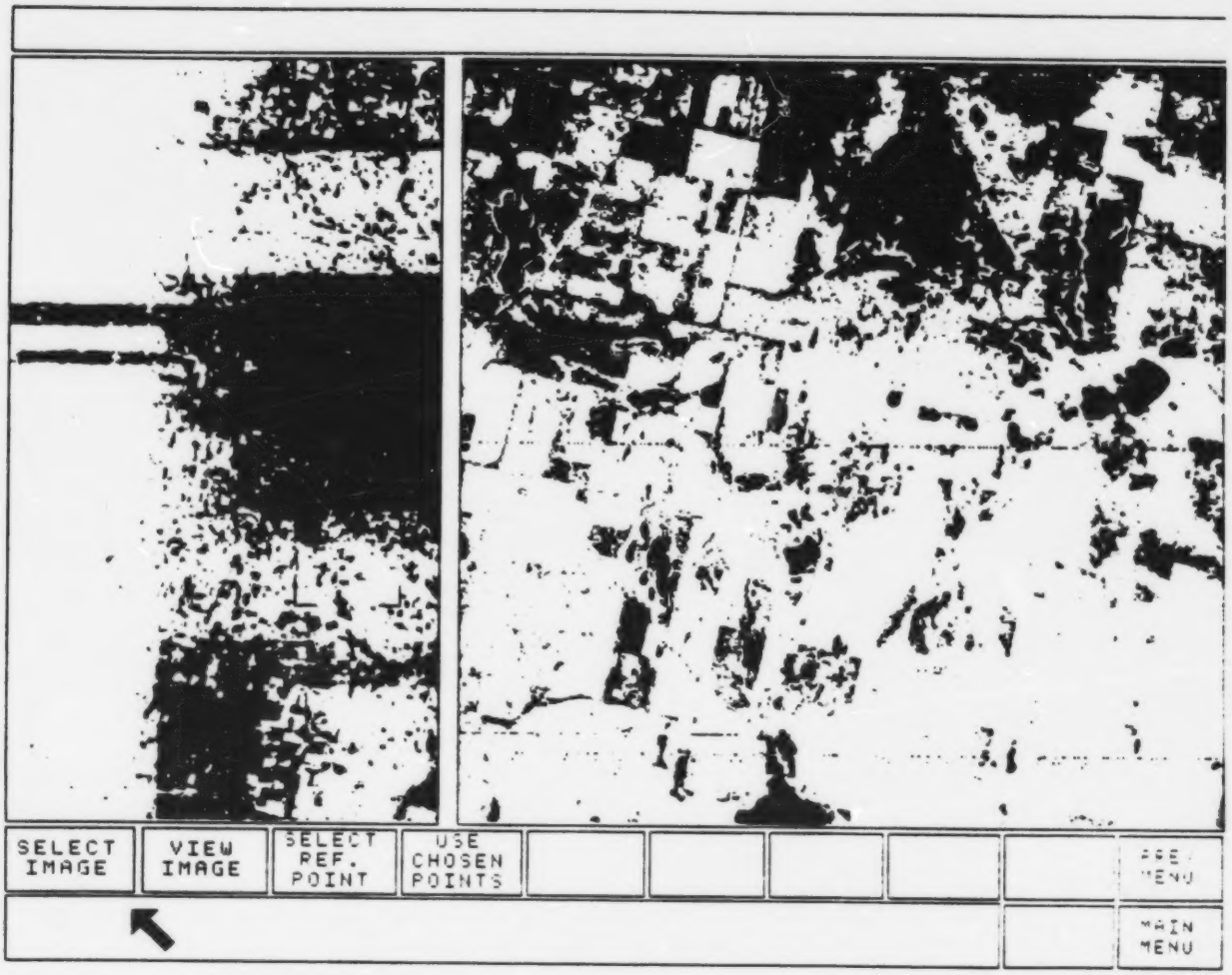


Figure 3.25 Georeference Image Menu

The general method for using this function is:

Select Image
This item is included so that the user may choose the flight line that they wish to georeference.

View Image
After the desired flight line has been selected through the SELECT IMAGE menu, the user must use the VIEW IMAGE functions to ensure that the next reference point to be entered appears in the Detail Window.

Select Reference Point
When the user has ensured that the next reference point is viewable within the Detail Window, they should select the SELECT REFERENCE POINT function. This causes the cursor to be "corralled" within the Detail Window in anticipation of the user selecting a reference point. An instructional message is displayed in the Message Window, as shown in Figure 3.26. The user should use the trackball to position the cursor over the desired point and then press the trackball button to identify the reference point to the system. At that time, a pop-up keyboard is presented and the user should enter the lat/long coordinates of the selected point. Note the proper format for the input as shown in the Message Window (Figure 3.27). The DELETE button may be used to erase the last character typed. When the user has entered the correct coordinate, they should select the CONFIRM button to save the information. If the user wishes to abort the whole operation (perhaps the trackball button was accidentally pressed before the cursor was positioned over the desired point), the CANCEL button can be used. Whenever the CANCEL button is pressed, both the selected point's position and any data "typed in" by the user are discarded. This action has no effect upon any previously entered reference point.
Note that entering reference points alone does not georeference the imagery: for that, see Use Chosen Points.

Use Chosen Points
When the user has finished entering reference points with the SELECT REFERENCE POINT function, they use the USE CHOSEN POINTS function to recalculate the flight line coordinates. If there has not been at least one reference point entered prior to selecting this function, a message appears in the Message Window and the operation is aborted (Figure 3.28).

Figure 3.26 Position Cursor

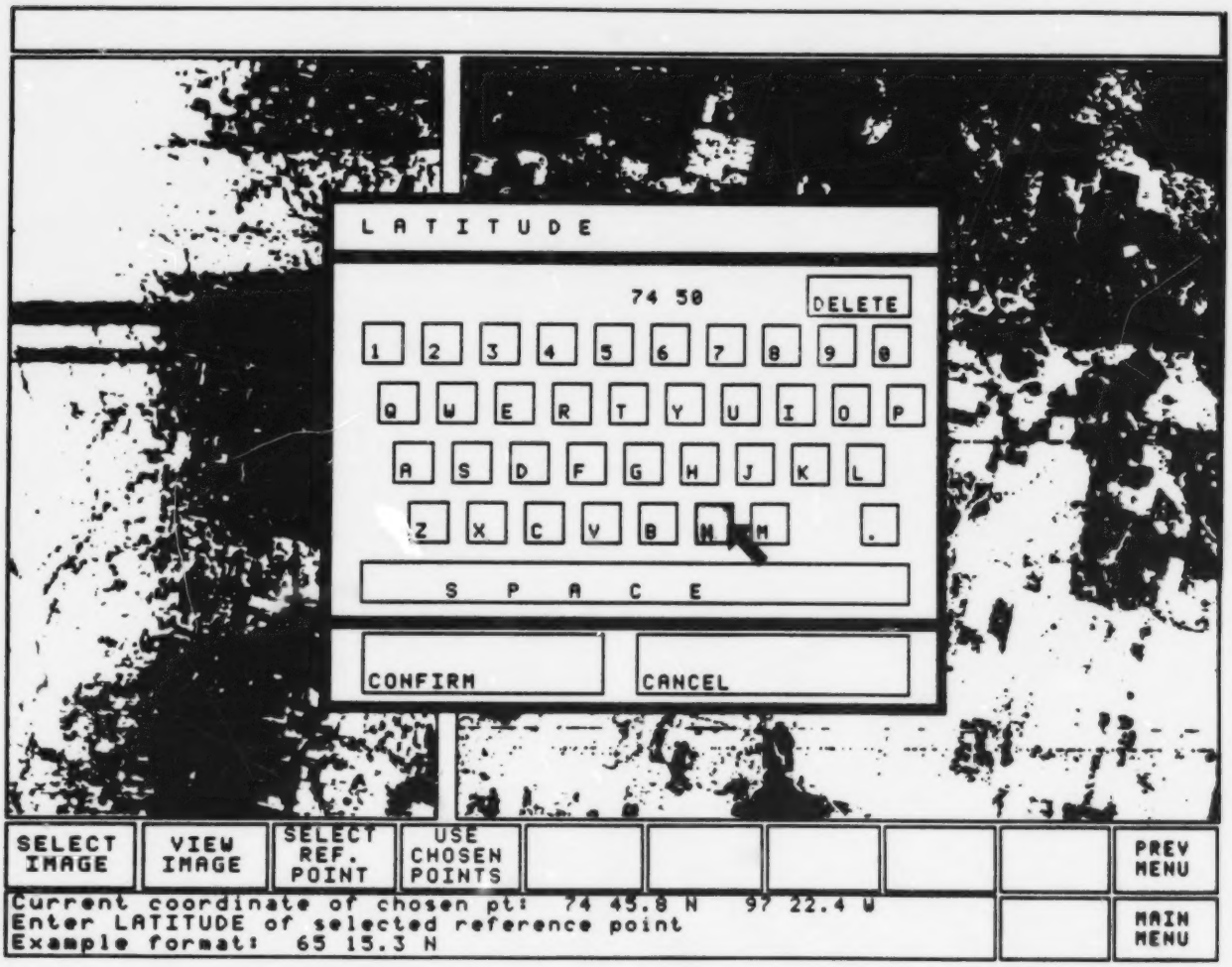

LATITUDE
74 50
DELETE
1 2 3 4 5 6 7 8 9 0
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M .
S P A C E
CONFIRM
CANCEL
SELECT IMAGE
VIEW IMAGE
SELECT REF. POINT
USE CHOSEN POINTS
PREV MENU
MAIN MENU
Current coordinate of chosen pt: 74 45.8 N 97 22.4 W
Enter LATITUDE of selected reference point
Example format: 65 15.3 N

Figure 3.27 Enter Latitude

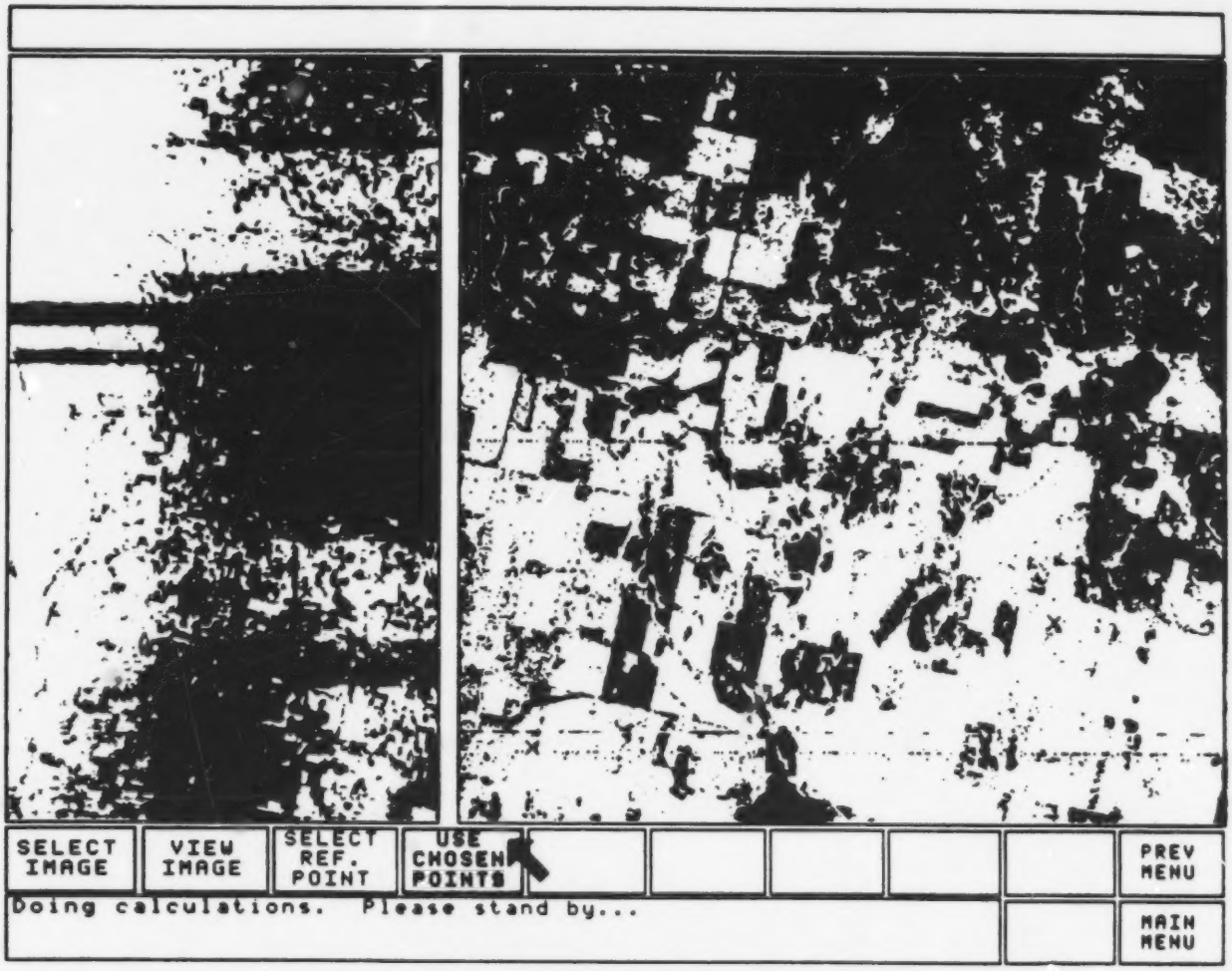


Figure 3.28 Stand By

3.8 MODIFY COLOUR LOOKUP TABLE

One of the planned enhancements to STAR-VUE was the incorporation of some primative image processing functions and a function to assign colour to the radar signal intensity values. It was thought that this may be useful for ice classification where targets and old ice could be highlighted and assigned colours for easy recognition.

Several functions have therefore been developed for this program. A new facility allows the user to alter the display characteristics of the imagery. Some common uses include changing the polarity of the imagery (positive to negative and vice versa), highlighting pixel values of a certain intensity (to make targets stand out), and performing pseudo-colour enhancement.

There are 16 colours used when displaying the imagery. Each of these colours can be changed independently of the others. For example, the brightest colour in the imagery (usually white) may be changed to blue, red or black, leaving all other colours unchanged. When changing an individual colour, it is possible to change the red, green, and blue components that make up any colour. Each of the 3 colour guns inside the display monitor can be set in the range of intensity from 0 to 255. This gives a palette of 256*256*256 or almost 17 million different colours available while in COLOUR mode. In MONO mode, equal intensity of the red, green, and blue values is used, so there are only 256 possible values or grey scales.

Upon selection of the MODIFY LOOKUP TABLE function, the user is presented with a screen as shown in Figure 3.29. On the left side, there are two vertical columns of 16 boxes labelled CURRENT and PROPOSED. The colours of the boxes represent the colours that are currently being used by the system and those colours that are being edited. On the right side of the columns there is a hand that points at one box. This is used to mark which colour was last selected. A colour is selected by moving the regular arrow cursor inside any of the 16 boxes in the proposed table and pressing the trackball button. Once a colour box is selected, that colour may be edited or identified as a start or end range.

On the right side of the display there are three separate boxes (if in COLOUR mode; MONO mode has only one). Each box graphically shows the intensity level of one of the red, green, or blue guns for the selected colour, by filling in the box from the left as the intensity increases. Under each box is written the current intensity value for that gun for that colour.

To edit the currently selected colour, move the cursor into one of the three boxes and press the trackball button. The intensity will then be altered by the horizontal

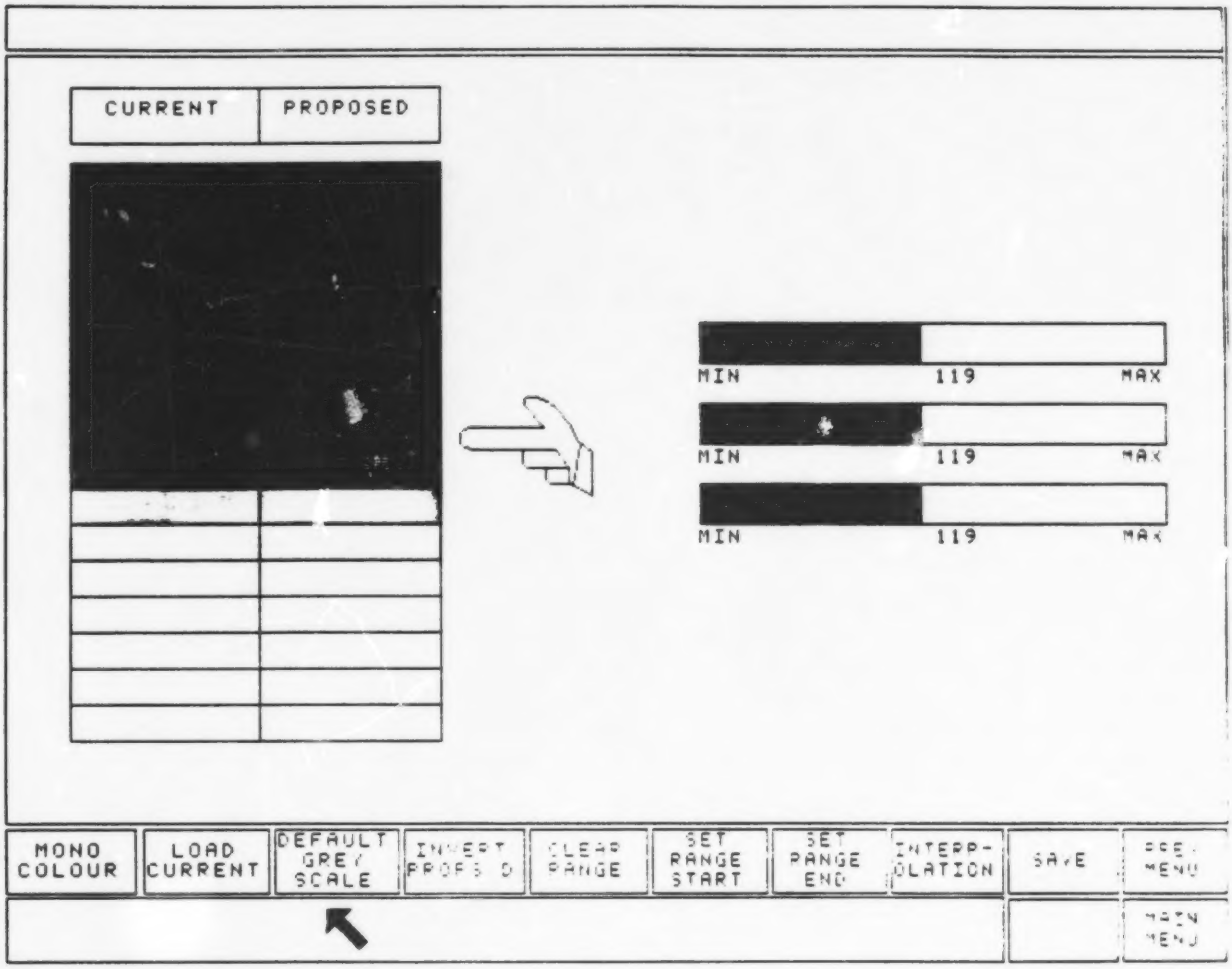


Figure 3.29. Modify Lookup Table Menu.

movement of the trackball. Rolling the trackball to the right increases the intensity while rolling to the left causes a decrease. The result of the movement is visible in three ways: the box fills in form the left for increasing intensity, the numerical value below the box is updated, and the colour of the selected box in the column on the left changes to reflect the user's actions. When the user is satisfied, they may click on the trackball button. This freezes the intensity that was being updated and the regular cursor becomes attached to the trackball once more.

It is also possible to edit a range of colours using the SET RANGE START, SET RANGE END, and INTERPOLATE functions. When interpolating, the system looks at two colours (the starting and ending colours) and notes their intensity values. It then adjusts the intensity of all colours in between so that the change in intensity between adjacent colours in the table is equal. This gives smooth transition between colours in the table and is especially useful where colour enhancement is being used.

The individual menu selections are detailed below.

Mono/ Colour

While in MONO mode, the three colour guns inside the display monitor are kept at the same intensity, thus limiting the available colours to grey scales ranging from black (all zero intensity) to white (all full intensity). While in COLOUR mode, the three colour guns may be changed independently, giving a much larger range of possible colours.

When in MONO mode, only one colour box appears on the right side of the display; in COLOUR mode, boxes for all three colours appear.

Load Current

As previously mentioned, there are two columns of boxes on the left side of the display representing the current colour set (CURRENT) and the set being edited (PROPOSED). This function is used to copy the current set onto the proposed set. This may be desired after a colour editing session does not give satisfactory results and the user wishes to begin editing from the current state.

Default Grey Scales

This function loads the proposed colour table with a linear set of grey scaled colours ranging from black to white. The previous colours in the table are lost.

Invert Proposed

This function is used to reverse the polarity of the proposed colour values. The value for colour 1 becomes that of colour 16, colour 2 becomes colour 15, and so on.

Clear Range
This function clears the START and END range markers used in interpolating.

Set Range Start
If the user wishes the system to do interpolation of intensities between two colours in the PROPOSED table, they must first select the two colours. This function makes the last colour selected (remember: colours in the table are selected by moving the cursor over the desired box and pressing the trackball button) the start colour for a subsequent interpolation command. The word START is drawn to indicate which is the start colour (Figure 3.30), and this colour remains so until the user uses the CLEAR RANGE function or reselects another colour from the table and then reselects SET RANGE START.

Set Range End
This function makes the last colour selected the end colour for a subsequent interpolation command. The word END is drawn to indicate which is the end colour (Figure 3.31), and this colour remains so until the user chooses the CLEAR RANGE function or reselects another colour from the table and then reselects SET RANGE END.

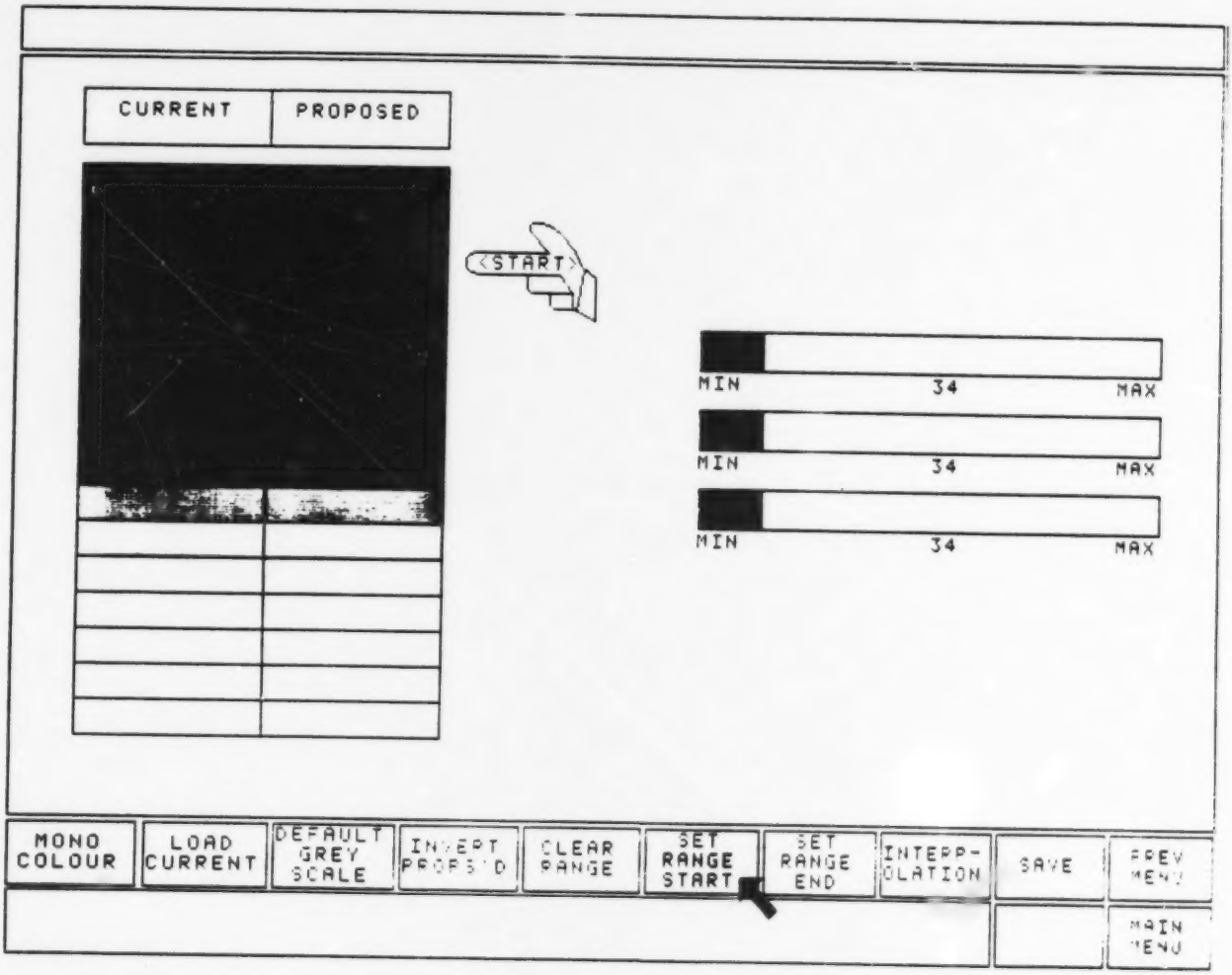


Figure 3.30 Set Start Range

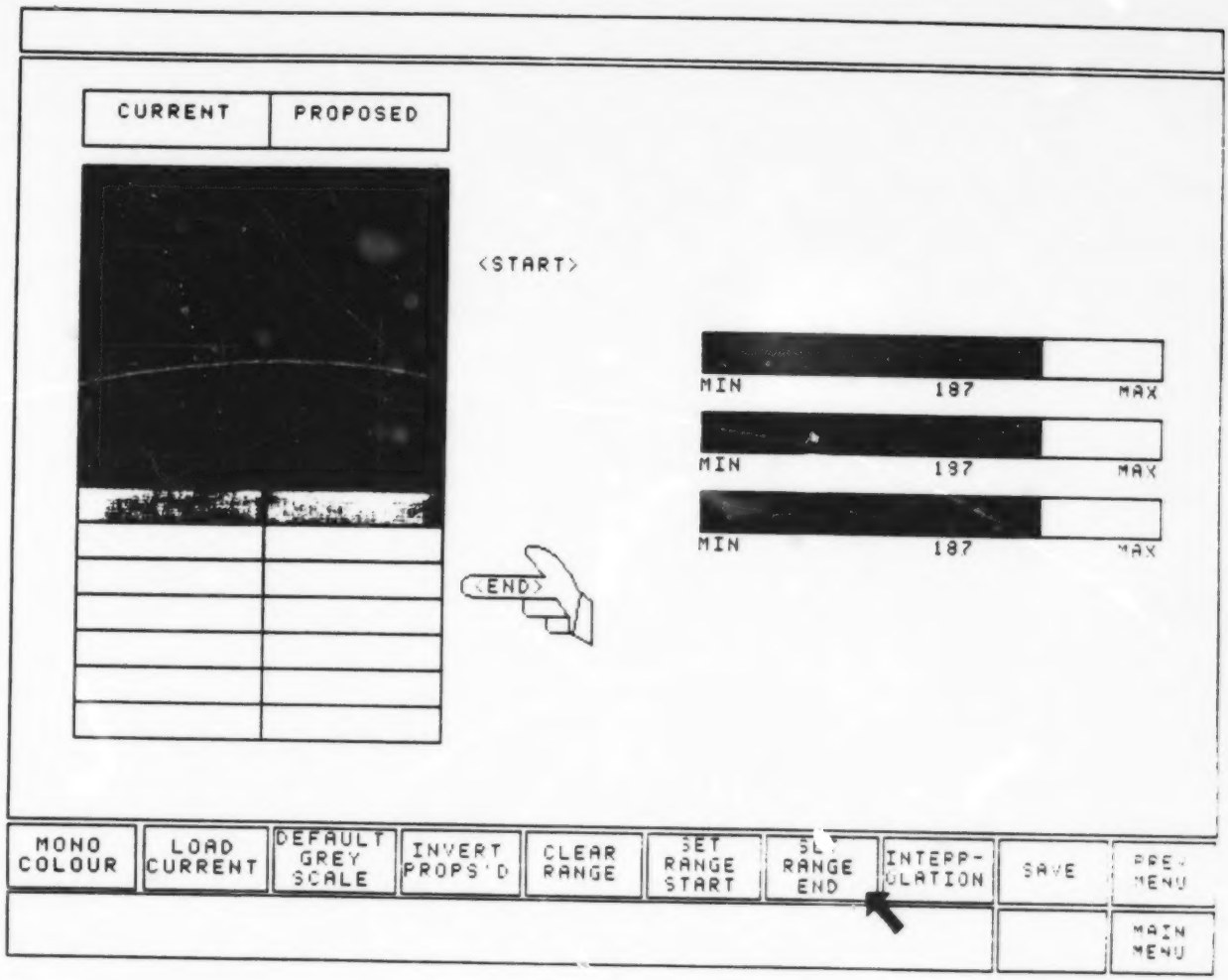


Figure 3.31 Set Range End

Interpolate

This function is used only after the operator has used both the SET START RANGE function and the SET END RANGE function to set the interpolation limits. If both ranges have not been previously set, a message appears in the Message Window (Figure 3.32) and no further action is taken. Otherwise, all colours in the proposed table in between the start and end colours will have their intensities modified so that the difference in intensity between any two adjacent colours is equal.

Save

This function is selected when the user is satisfied with the colours in the proposed table and wishes to use them. The current table is overwritten with the proposed table values.

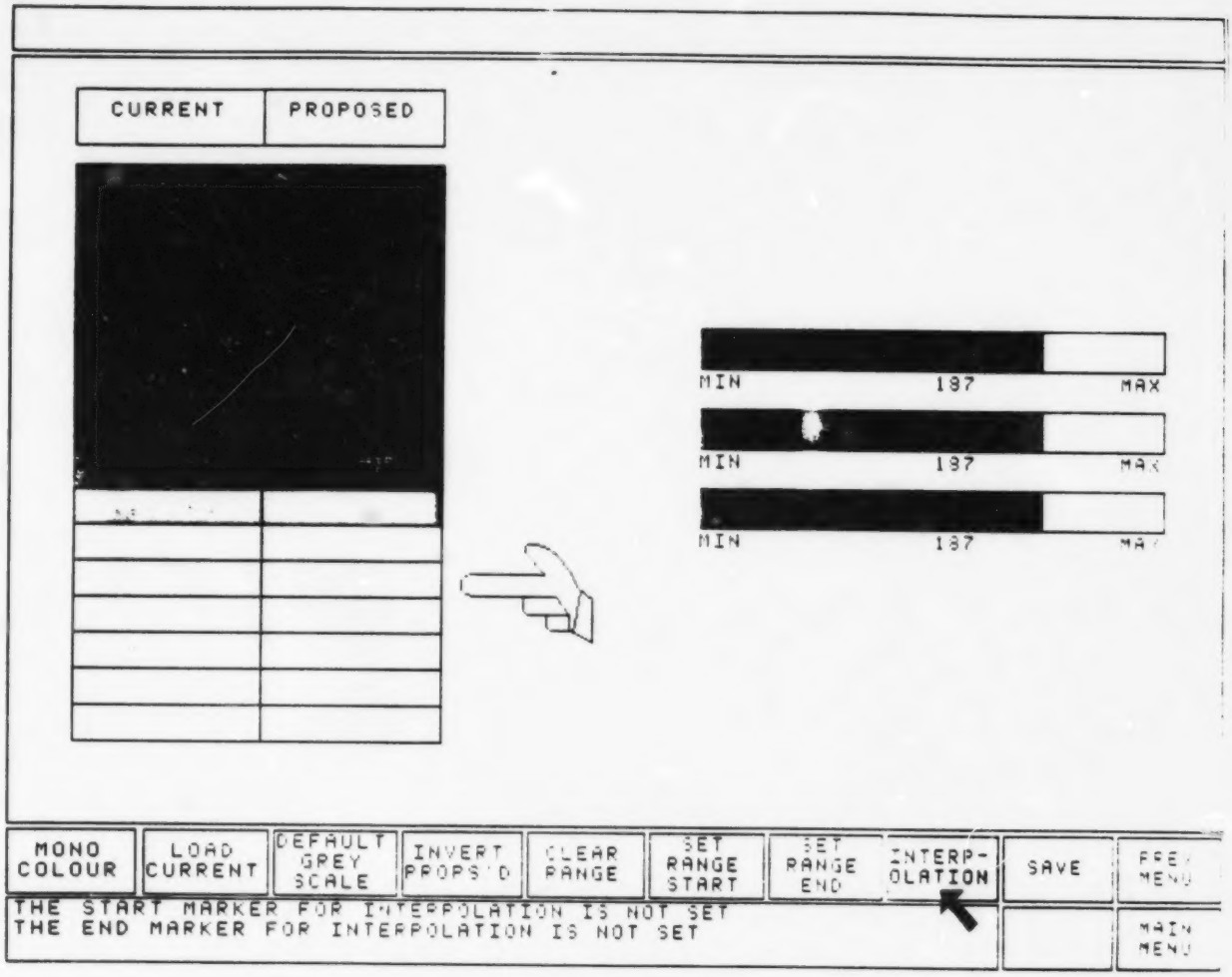


Figure 3.32 Range Not Set

3.9 CREATE REGION

One of the functions that has been enhanced with the addition of the pop-up keyboard is the CREATE REGION function. The CREATE REGION menu provides all the required functions to create defined regions which can be displayed quickly. When the CREATE REGION button is pressed, the CREATE REGION menu is displayed (as shown in Figure 3.33). This menu is very similar to the SELECT IMAGE menu. However, unlike the drawing operations in the SELECT IMAGE menu, image coverage boxes are not displayed. Within the CREATE REGION environment, a map can be drawn by selecting a defined region and/or changing the map center and scale. This process can be done as many times as needed to create a defined region map.

This menu presents the standard buttons described previously (PREVIOUS MENU and MAIN MENU), as well as the following ones:

WORLD MAP: This button presents a map of the "world". Image coverage boxes are not drawn.

SELECT DEFINED REGION: This button allows the operator to choose among a number of defined geographical regions.

ZOOM IN: This button increases the scale of the map (i.e., provides more detail). This scale change will take effect the next time the REDRAW button is pressed.

ZOOM OUT: ZOOM OUT performs the opposite function from ZOOM IN. It decreases the scale (i.e., covers a larger area).

MAP CENTER: The MAP CENTER button allows the operator to make adjustments in the location being displayed. The map can then be redrawn with this new center point.

REDRAW: The REDRAW button is used to request STAR-VUE to redraw the displayed map based on the new (next) scale and center parameters.

SAVE: The SAVE button creates and stores the map which is currently displayed as a defined region. If the map on the screen is satisfactory, the SAVE button may be pressed to create a new defined geographical region. At this point, a pop-up menu with all the alphabetical keys is displayed for entering the region name. The layout of the alphabetical keys is identical to the layout of a standard keyboard. The region name is entered by pressing the appropriate alphabetical and numerical keys in the pop-up menu. The name is displayed in the display area of the pop-up menu while it is entered (Figure 3.34). The DELETE key is used to erase the last character in the

display window. The user may press the CANCEL button to cancel the operation at any time or press the CONFIRM key after the region name is entered.

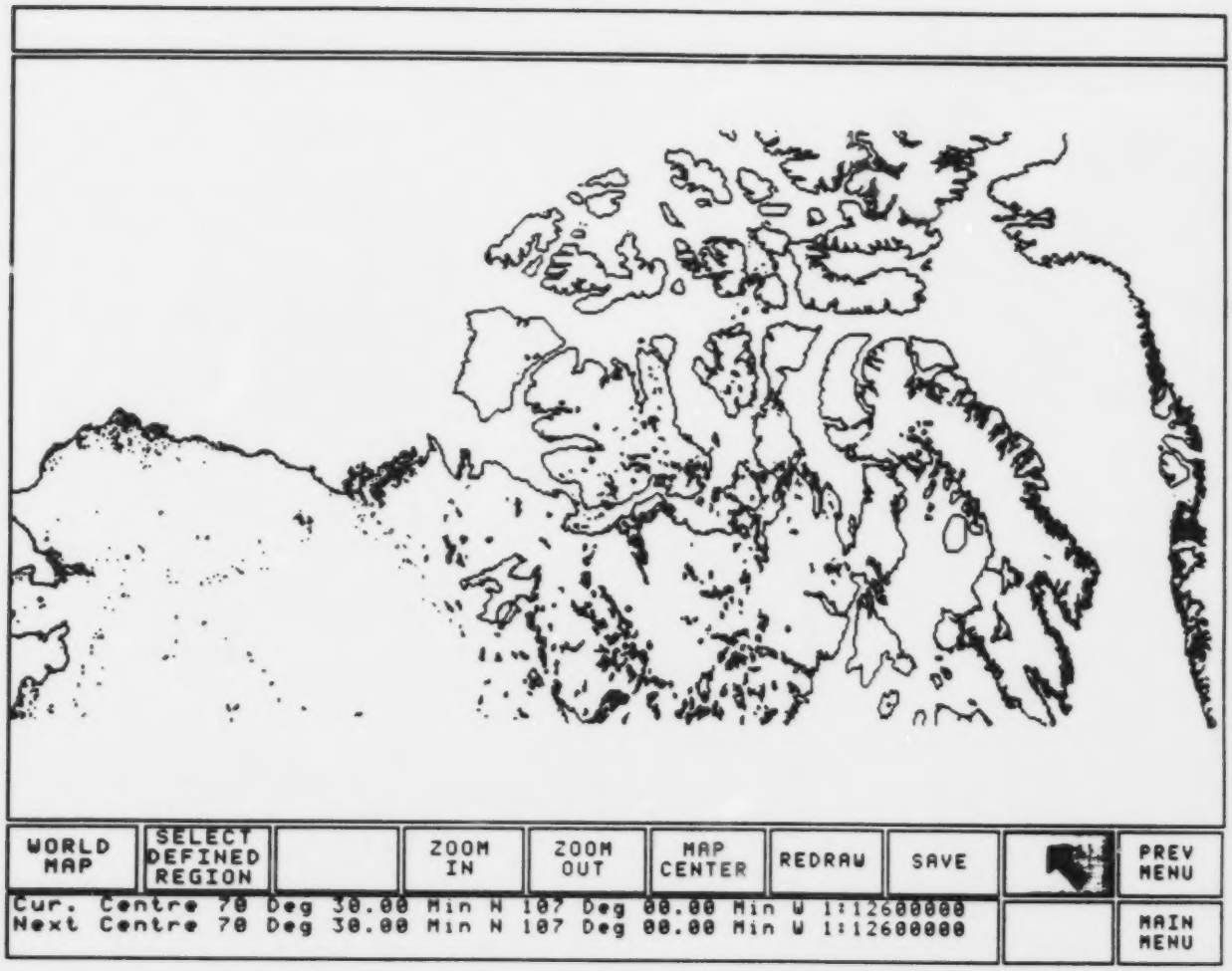


Figure 3.33. The Create Region Menu.

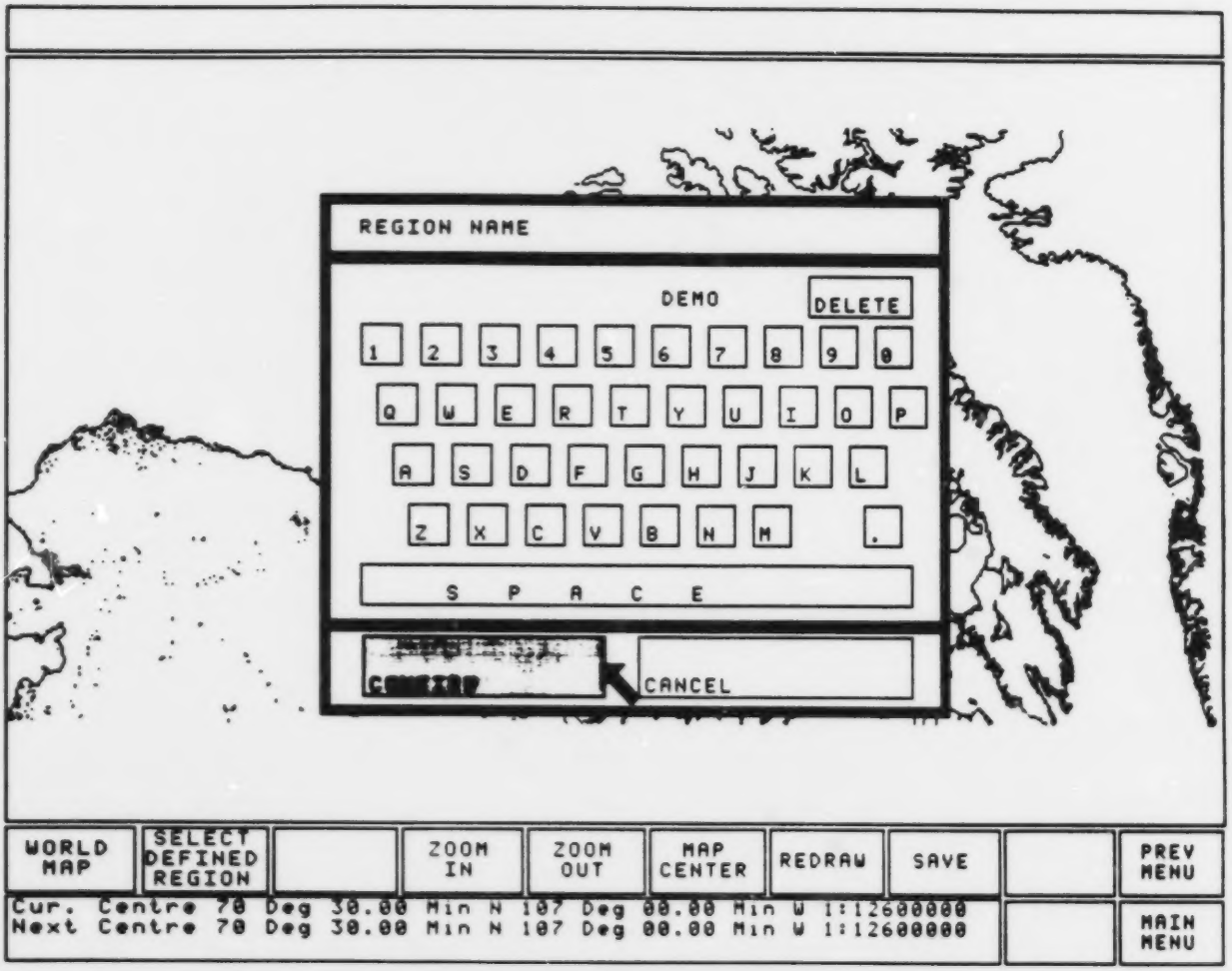

REGION NAME
DEMO
DELETE
1 2 3 4 5 6 7 8 9 0
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M .
S P A C E
CANCEL
WORLD MAP
SELECT DEFINED REGION
ZOOM IN
ZOOM OUT
MAP CENTER
REDRAW
SAVE
PREV MENU
MAIN MENU
Cur. Centre 70 Deg 30.00 Min N 107 Deg 00.00 Min W 1:12600000
Next Centre 70 Deg 30.00 Min N 107 Deg 00.00 Min W 1:12600000

Figure 3.34. Entering the name for the defined region.

If the region name is confirmed, the operator will be asked to wait. The saving function takes a few seconds to complete. The operator should not select any other function until the saving has been completed.

After a region is created, the user may create more regions or exit from the CREATE REGION menu. If the map has been saved successfully, it can be retrieved via the SELECT DEFINED REGION button .

3.10 MANAGE RECEIVED DATA

This menu has been added to manage all the received flight line data. This includes setting protection for imagery and deleting imagery.

The buttons available in this menu are the standard buttons (PREVIOUS MENU and MAIN MENU), SELECT IMAGE, LOCK/UNLOCK IMAGE, LIST STORED FLIGHTS and DELETE DATA.

SELECT IMAGE: This button can be used to display another map.

LOCK/UNLOCK IMAGE: The LOCK/UNLOCK button allows the operator to set/remove data protection. Only unlocked data can be deleted. This feature minimizes the chance of deleting valuable data by accident.

Once the LOCK/UNLOCK button is pressed, a pop-up menu with the names of all the received imagery will be displayed. Names of locked imagery are highlighted. The operator may move the cursor to the desired name and click once (Figure 3.35). This will cause the lock/unlock status of imagery to be toggled. More than one imagery can be lock/unlocked before the confirmation.

Data protection is set/removed after the operation has been confirmed with the CONFIRM button, and the pop-up menu will disappear.

LIST STORED FLIGHTS: This button provides the ability to remove or include flight lines being displayed on the map.

DELETE DATA: The DELETE IMAGE button is used for deleting imagery data so that more disk space can be recovered. The DELETE IMAGE button is used for deleting imagery data so that more disk space can be recovered. The operator should use this button carefully because deleted data cannot be recovered.

Once this button is pressed, a pop-up menu with the names of all the received and unlocked imagery is displayed. The operator may select the imagery on the pop-up menu (Figure 3.36). Only one image can be deleted at a time. Therefore, if users

choose another image before it is confirmed, this will replace the previous selection. The selected imagery will be deleted if confirmed. After the deletion, the corresponding coverage box on the screen will be erased.

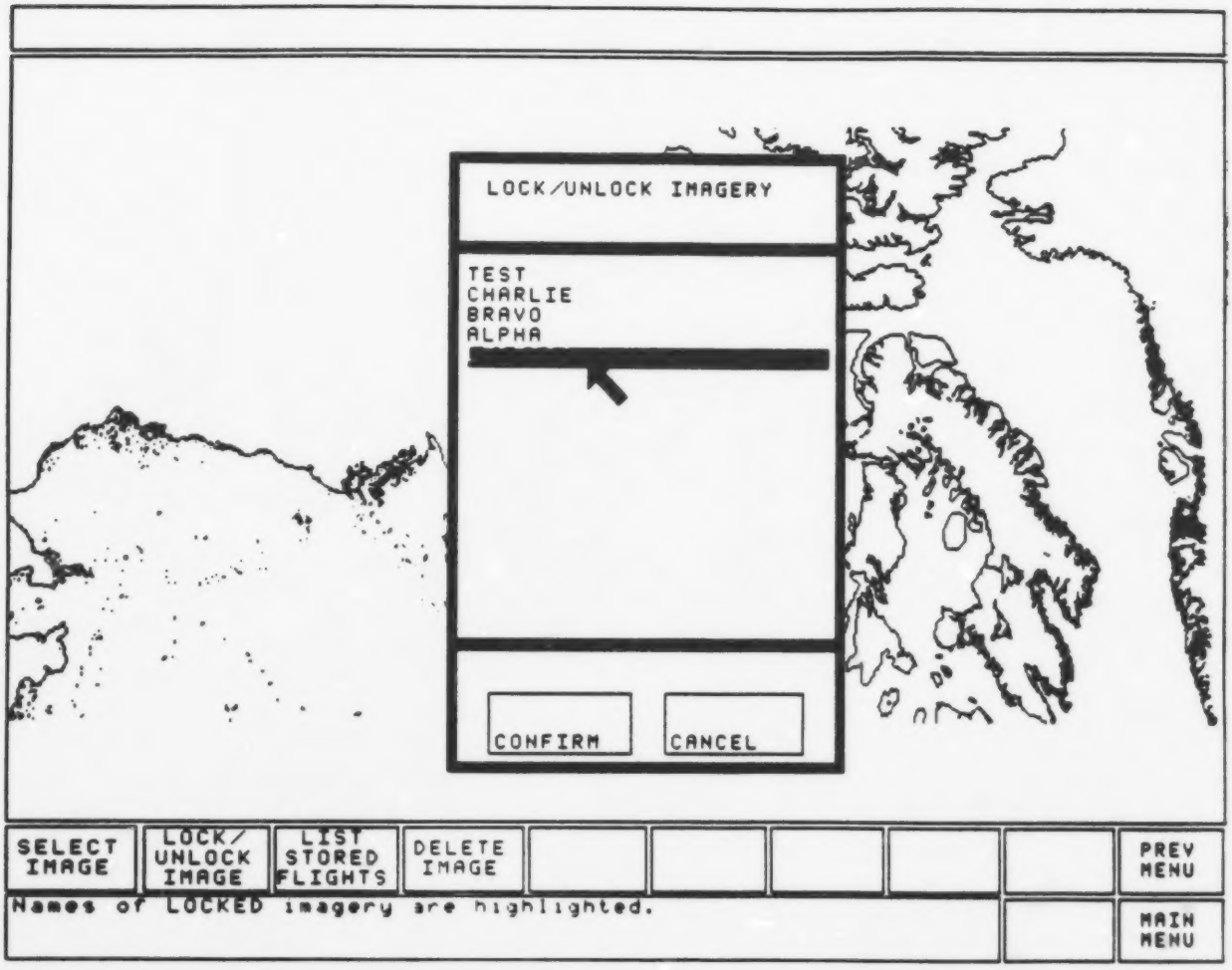


Figure 3.35 Changing the Lock/Unlock Status of an Image.

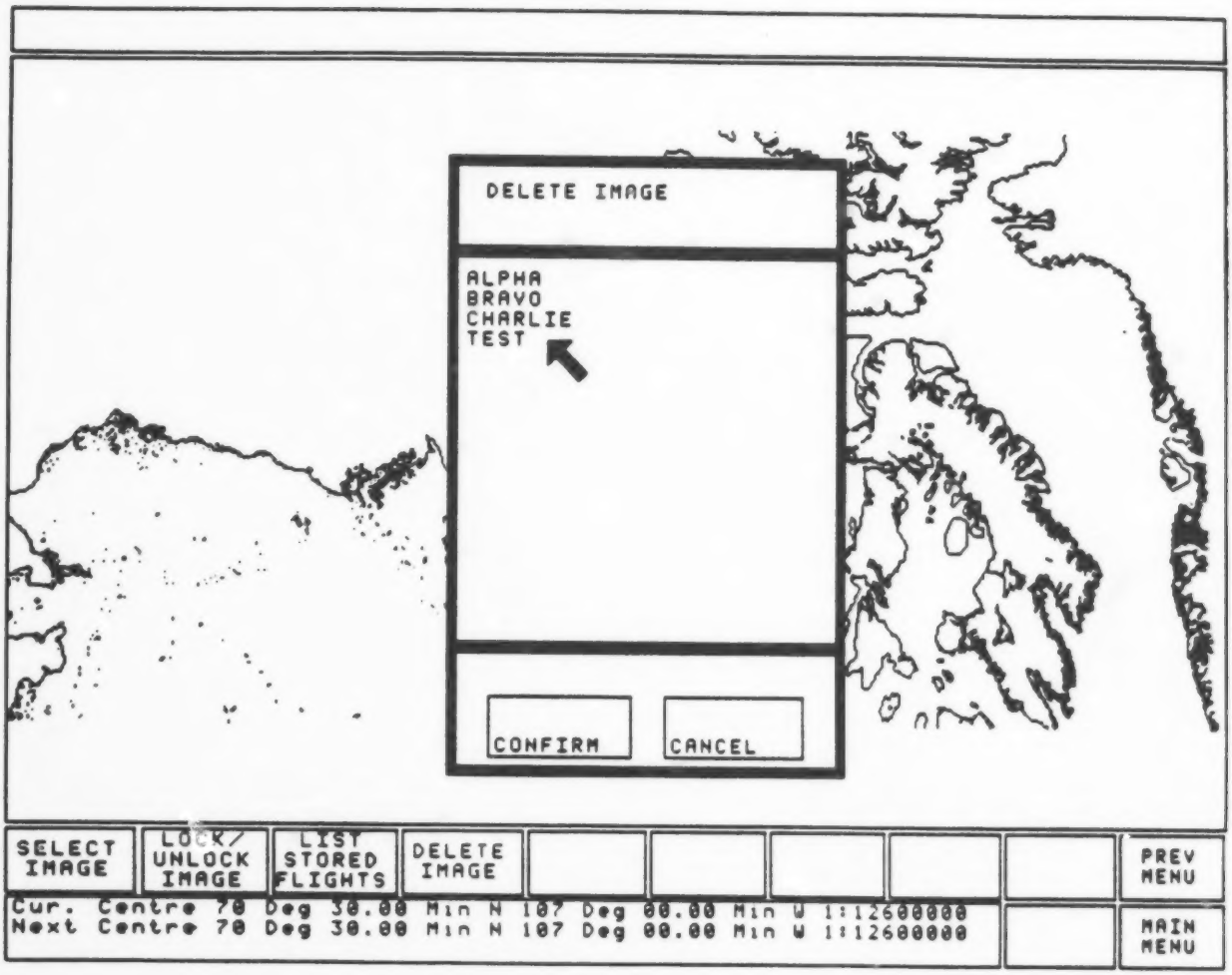


Figure 3.36 The DELETE IMAGE Pop-Up Menu.

4. COAST GUARD FIELD TRIALS

Although not part of this contract, the STAR-VUE and MARINE-VUE system were tested on the CCGS Louis St. Laurent during February 1987.

Despite some minor equipment problems with STAR-VUE, which primarily stemmed from the introduction of the new STAR-2 aircraft, the system was demonstrated as a navigation tool to the ship's personnel. Mr. Doug Hagen, an independent ice observer from Norland Engineering hired by INTERA for this mission, claimed in his report to INTERA, "After approximately a day of regularly informing the Captain of the upcoming ice conditions and pointing out the ship's location as it moved across the imagery, it would seem reasonable to say that given accurate interpretation of the imagery and confident use of the STAR-VUE system, the Coast Guard vessels will provide a very good platform for testing and developing the system." It was discovered that the interpretation and utilization of the SAR imagery in the Gulf of St. Lawrence is certainly more complex than the Arctic, where the predominate ice types are old ice and thick first-year; these ice types are easily distinguished on the SAR. However, it can be said that when operating in the Gulf, the necessary information in and around first-year ice is easily obtained from the imagery. In the proximity of light ice (<15 cm) where a vessel is typically not being impeded, much greater interpretation skill is required. The fact that both these ice types can be distinguished on the SAR imagery is very valuable in itself.

The representative from Ottawa had mixed impressions on the effectiveness of STAR-VUE. There was a concensus that the system surely has potential and does provide a milestone improvement as compared to conventional facsimile "egg chart" broadcasts. However, as to the effectiveness as a navigation instrument, software development must continue to at least alleviate some of the more obvious deficiencies which were apparent during this evaluation. In their opinion these include: the lack of north-up presentation; need for a superimposed latitutde/longitude grid; high resolution imagery not being available in real time; a simple means of measuring ranges and bearings (currently only available on a sub-menu); not knowing the geographic location and scale of the roam box; and the ability to readily produce hardcopy to a selected scale compatible to the available navigation charts. The EDO printer is also less than satisfactory. There is, of course, a need for ongoing training in the proper interpretation of ice imagery. The training of ships' officers can be addressed with appropriate courses and training systems. There are also several planned additions to the STAR-VUE system in the near future which will make it much easier to use. The most important of these features will be the complete use of an annotated data stream.

The current STAR-VUE system has been designed to handle the currently available unannotated SAR and SLAR systems. As such it requires that the user specify the coordinates of each flight light both before and after each mission. This is a time-consuming procedure and it is difficult to supply accurate start and end coordinates. The STAR-2 radar does supply bit mapped annotation on the imagery itself. Each flight line has a header with the latitude and longitude indicated. In addition, the latitude and longitude crossings are indicated every 10 minutes by crosshairs stamped on the imagery. This was available for the Gulf demo. In addition, annotation information is also imbedded at the start of each range line and can be downlinked to STAR-VUE.

A planned upgrade to STAR-VUE will allow the system to automatically read this imbedded information and geographically annotate the data. No operator intervention would be required for data reception. In addition, a latitude and longitude grid that can be turned on or off will be superimposed on the imagery. These features will simplify the operation of STAR-VUE and reduce the operator workload. Other features which were suggested as a result of the demonstration include:

1. A method of keeping the annotation fixed on the imagery depsite changes to the shape and size of the roam box;

2. The development of a mosaicing function to paste several flight lines together;

3. Incorporating a smooth scroll on the overview window; and

4. Incorporating a method of storing the colour look-up tables which can be assigned to various ice types when classifying.

Colour was found to be very useful by the Norland Ice Observer when classifying the ice in the Gulf. Colour, however, can be very distracting to many individuals and more work needs to be done to determine its utility.

The personnel on the ship concluded that 32 m resolution data were adequate for most ice interpretation in the Gulf. The 16 m data that were available provided more detailed information but the operators claimed they were a little more difficult to work with since they required more disk storage on the system. This would not be a problem for a system with a larger disk capacity.

It is unfortunate that due to interfacing problems, the MARINE-VUE system could not be evaluated during the demonstration period. Canarctic's experience in the Arctic has

shown that a bright marine radar display system is essential for locating the position of the ship on the SAR imagery when ice conditions have changed. The marine radar can provide a valuable link between whre the ice was at the time the SAR imagery was collected and where it is in relation to the ship.

Although Coast Guard may not choose to navigate with the SAR and marine radar imagery in the same way Canarctic does, it is important that they fully evaluate this concept of using both data sources before dismissing the marine radar display system. The marine radar provides valuable real time information which can extend the usefulness of the SAR. The more information that a ship's officer has on the ice conditions surrounding his vessel the better the decision he can make on steering a course that avoids potential damaging consequences.

5. CONCLUSIONS

This report has summarized the continued development of the STAR-VUE and MARINE-VUE system. The primary objective of the program was to implement and test defined upgrades to those systems.

The upgrades to STAR-VUE included software additions that were recommended as a result of shipboard testing. These upgrades included the addition of new facilities to enter latitude and longitude information, image and colour enhancement, a program to georeference the imagery, a new data reception handler, and many other small additions to improve the system effectiveness for the task of navigation in ice.

A completely new design for an improved stand-alone MARINE-VUE system has also been developed. INTERA is currently implementing this design and will test the new system early in 1988.

The Coast Guard documentation of these systems in February 1987 resulted in several recommendations being made concerning STAR-VUE. Each of these recommendations has been addressed by INTERA and will be incorporated into the new STAR-VUE systems that INTERA will supply to Coast Guard for the AES program in 1989. It was clear from the Coast Guard trials that future programs must focus on the problems of training officers in the use of these new systems as well as in the interpretation of SAR radar data.